OUR LIVING OCEANS

REPORT ON THE STATUS OF U.S. LIVING MARINE RESOURCES, 1993

UNITED STATES
DEPARTMENT
OF COMMERCE

OUR LIVING OCEANS

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U.S. DEPARTMENT OF COMMERCE

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PREFACE

This third status review of U.S. living marine resources (LMR's) updates and augments the 1992 "Our Living Oceans" document. It provides a scientific overview of the health of the Nation's marine fisheries as well as protected marine mammals and sea turtles. These national resources are under the stewardship of the National Marine Fisheries Service (NMFS), a line office of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). This report synthesizes, for the public, results from extensive NMFS scientific programs aimed at evaluating and monitoring our living marine resources. The management of these resources is described, and important issues and recent progress are highlighted. As with the first two editions, it is the collective effort of NMFS staff from around the country that makes such a report possible (Appendices 1 and 2).

FOREWORD

ASSISTANT ADMINISTRATOR'S MESSAGE

Vice President Al Gore completed his report on the National Performance Review in September of 1993, shortly before I was appointed to head the National Marine Fisheries Service. One of the main conclusions of the Vice President's study, emphasized by President Bill Clinton at the signing of the Government Performance and Results Act, is that government agencies must evaluate and focus on the outputs of their work, rather than just the inputs. In effect, we need to measure how well we have done in achieving our goals. The National Performance Review also points out that Federal agencies need to work under strategic plans and link these plans to performance and results.

This third annual report on the status of U.S. living marine resources is just such an evaluation of performance to accompany the NOAA and NMFS Strategic Plans. It gives an overview of the status of all our living marine resources and illustrates both successes and shortcomings in our stewardship of these resources for the Nation. This report highlights important problems which we, as managers, must face and deal with over the coming years. It highlights as well, the substantial progress we have made within just the past year.

The National Marine Fisheries Service, with its origin as the U.S. Commission of Fish and Fisheries in 1871, was this Nation's first environmental agency. In 1996 we will celebrate our 125th anniversary. We recognize and understand the problems we face. Our long history has given us the experience and expertise to make progress in resolving them. This report shows the many areas of resource management where we need to improve. We must reverse the overfishing trend, improve economic performance, and strengthen the conservation of protected species. As Assistant Administrator for Fisheries, I intend to focus on the Agency's performance in improving the management of our living marine resources through better understanding of the status of the resource, improved communications with the user community, and a streamlined and effective National Marine Fisheries Service. Our ultimate goal is to insure the greatest possible benefit for the Nation on a continuing basis.

Rolland A. Schmitten
Assistant Administrator for Fisheries
National Oceanic and
Atmospheric Administration

December 1993

Part 1: OVERVIEW

OUR LIVING MARINE RESOURCES

The living marine resources of the United States are an extremely valuable heritage. In 1992, U.S. commercial fishermen earned $3.7 billion in ex-vessel revenue on 4.8 million metric tons of fish and shellfish. About 80% of these landings were used directly for human food. The commercial harvesting and seafood processing sectors support over 300,000 full-time jobs. With almost 6% of the world's commercial landings, the United States is the sixth largest producer of seafood in the world.

These marine resources also support many other important uses. For example, off the Atlantic and Gulf of Mexico coasts approximately 17 million U.S. recreational fishermen took over 52 million saltwater fishing trips and caught more than 285 million finfish in 1992. Subsistence fishing by Native Americans and recreational activities such as whale watching also are supported by the various resources. To this end, the protection and recovery of depleted stocks of marine mammals, sea turtles, and other threatened and endangered species can yield important benefits for the Nation.

NMFS responsibilities are primarily set out in several major pieces of legislation: 1) The Magnuson Fisheries Conservation and Management Act (MFCMA) for conservation of fisheries resources in the U.S. Exclusive Economic Zone (EEZ), 2) the Marine Mammal Protection Act (MMPA) for monitoring, protection, and management of marine mammal stocks in U.S. waters, 3) the Endangered Species Act (ESA) for monitoring and protection of marine life considered at risk of extinction, 4) the Fish and Wildlife Coordination Act and 5) the Federal Power Act, both of which provide concurrent responsibilities with the U.S. Fish and Wildlife Service for protecting aquatic habitat.

Each of these laws has a primary requirement that the best scientific information be used as the basis for management actions. NMFS takes a leading role in the collection and analysis of scientific data on living marine resources. The Agency prepares hundreds of specialized scientific reports each year along with numerous oral presentations and technical documents for fishery managers, industry groups, and the public.

The Secretary of Commerce is ultimately the manager, through NOAA's NMFS, of most of the living marine resources in the 200-mile EEZ (Fig. 1). Management plans are developed through extensive discussions with other state and Federal government agencies, public interest groups, and in some cases, international science and management organizations.

The MFCMA established eight Regional Fishery Management Councils (Councils) for the development of Fishery Management Plans (FMP's) for the Nation's fishery resources. The Councils represent diverse interests through members nominated by state governors in each region and appointed by the Commerce Secretary. For some fisheries and for protected resources such as marine mammals and sea turtles,

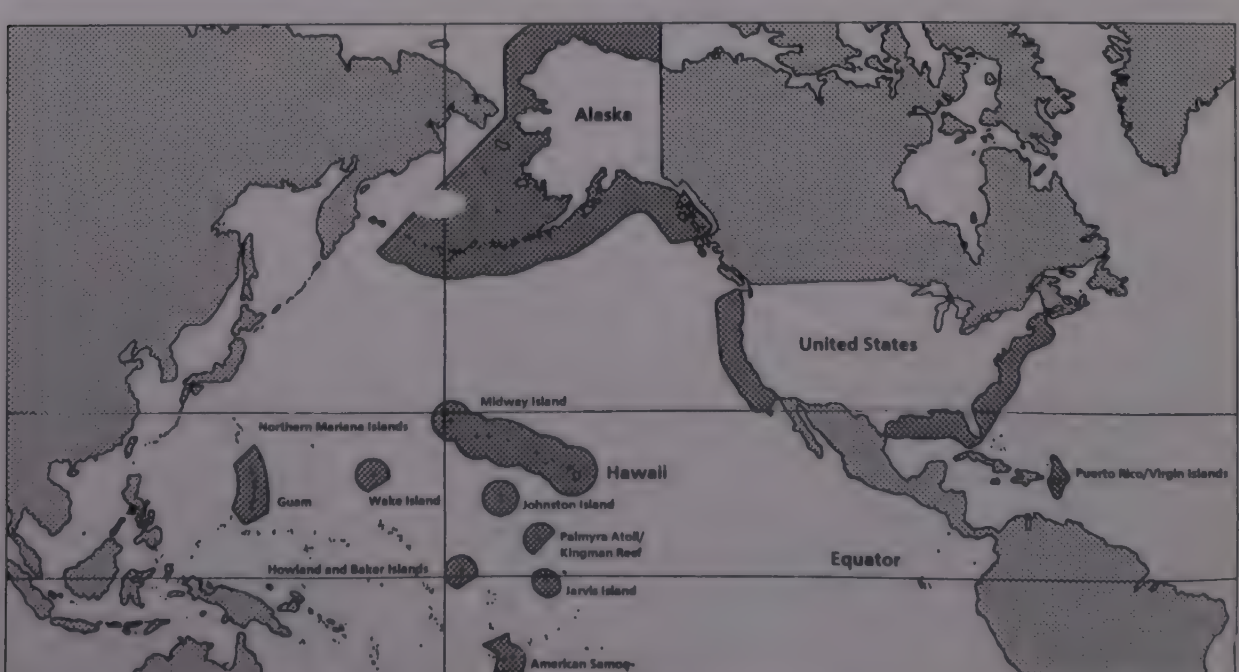

Figure 1.–Exclusive economic zones of the United States (adapted with permission from a map by Mary Beath in "A Nation of Oceans," published by the Center for Marine Conservation).

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fishery management plans and protected species recovery plans are developed directly by NMFS, with advice and comment from the public including the regional councils. Appendix 3 lists the Councils and FMP's currently in place.

This report provides a broad overview of the large body of technical information, which supports the development and implementation of FMP's. It considers most living marine resources of interest to the United States (either harvested partially or totally by the United States or present in the U.S. EEZ for a portion of their life). The status of each resource is evaluated, and current and potential harvest levels are given, along with information on current management controls. More detailed information on specific resources is contained in the regional "Status of Fisheries Resources" reports available from NMFS fisheries science centers around the country (Appendix 2).

The first section of "Our Living Oceans" contains a national overview of our living ocean heritage. It includes this introduction, a brief discussion of scientific principles and terms, region by region resource summaries, an overview of issues of national concern affecting all regions, and a discussion of progress made during the last year. Section one also includes a "spotlight" article — this year, an essay examining the history of management of Atlantic striped bass, a resource once in decline but now recovering under cooperative management by states and the Federal government.

Section two reviews in greater detail the status of regional LMR's in 24 separate units. These unit synopses describe species and/or species groups linked geographically, ecologically, and by characteristics of harvesting operations. Appendices, the third section, list the principal NMFS facilities around the country, the Councils, FMP's, recent FMP amendments, and the scientific and common names of the species covered in this report.

INTRODUCTION

Much of the information in this document comes from the scientific analysis of fisheries data to develop **stock assessments**. In general terms, a stock assessment includes an estimation of the amount or abundance of the resource, an estimation of the rate at which it is being removed due to harvesting and other causes, and one or more reference levels of harvesting rate and/or abundance at which the stock can maintain itself in the long term. Such assessments often also contain short-term (1-5 years, typically) projections or prognoses for the stock under a number of different management scenarios. This information on resource status is used by policy makers and managers to determine what actions are needed to promote the best use of our marine resources.

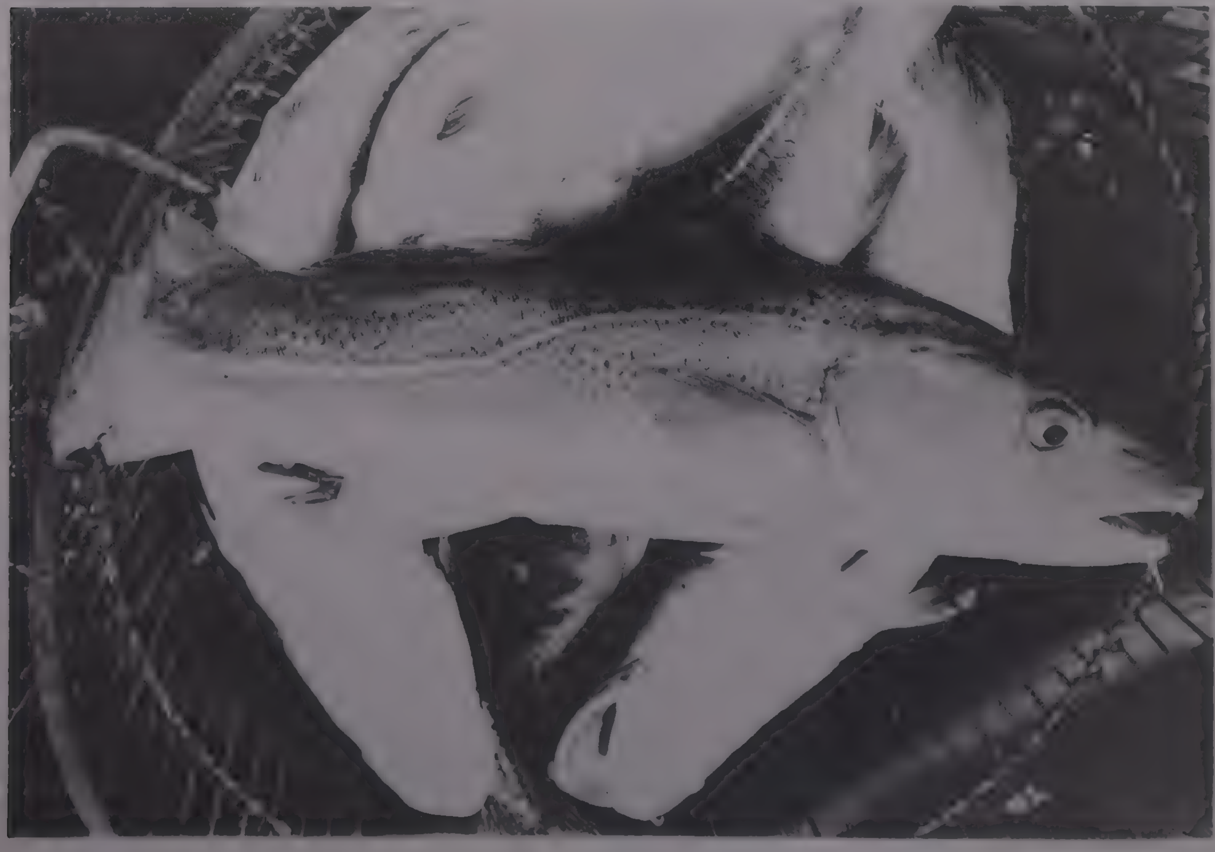
A POPULATION IS a group of animals that are genetically related owing to interbreeding. Ideally, populations should be considered distinct groups for fishery management purposes. But it is difficult to determine which individuals of a species form a population, and it may not be practical to manage them as a population. Thus, this report uses the term "population" to identify interbreeding biological groups. The term "stock" is used to identify groups of animals for management purposes.

Stock assessment analyses rely on various sources of information to estimate resource abundance and population trends. The principal information comes from the commercial and recreational fishery harvests themselves. For example, the amount of fish caught, the individual sizes of the fish caught and their biological characteristics (e.g., age, maturity, sex), and the ratio of fish caught to the time spent fishing (catch per unit of effort) are the basic data for stock assessments. In addition, NMFS conducts dozens of resource surveys with specialized research vessels or chartered fishing vessels every year. These surveys, sometimes done in cooperation with state marine resource agencies, universities, international scientific organizations, or even with the fisheries agencies of other nations, produce an index of the resource abundance.

Research surveys are very different from commercial fishing. While commercial operations seek out the greatest aggregations of fish and concentrate on them to obtain the largest or most valuable catch, research surveys fish in a standardized manner over a wide range of locations within the waters inhabited by the stocks to provide a consistent population abundance and distribution index year after year. The survey results are then used in conjunction with commercial and recreational catch data to assess the resource base. The final critical data comes from studies on the basic biology of the animals of the sea. Understanding the natural history of the harvested species and the other species with which they interact is crucial to understanding overall resource status.

Fish abundance or population size can be expressed as either the estimated number of fish or the estimated total fish weight (or "biomass"). Increases in the amount of fish are determined by body growth of individual fish in the population,

Atlantic cod



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and the addition or **recruitment** of new generations of young fish (i.e., "recruits"). Those gains must then be balanced against the proportion of the population removed by harvesting (called **fishing mortality**) and other losses due, for example, to predation, starvation, or disease (called **natural mortality**). In stock assessment work, removals of fish from the population are commonly expressed in terms of rates within a time period. The **fishing mortality rate** is a function of **fishing effort**, which includes the amount, type, and effectiveness of fishing gear and the time spent fishing.

Surplus production (or just "production") is the total weight of fish that can be removed by fishing without changing the size of the population. It is calculated as the sum of the growth in weight of individuals in a population, plus the addition of biomass from new recruits, minus the biomass of animals lost to natural mortality.

The **production rate** is expressed as a proportion of the population size or biomass. The production rate is highly variable owing to environmental fluctuations, predation and other biological interactions with other populations. On average, production decreases at low and high population sizes. Thus, surplus production tends to be low at the extremes of population size (i.e. where biomass or production rate is low). It is more likely to be high at some intermediate level of population biomass. But, on average, biomass decreases as the amount of fishing effort increases (Fig. 2, dashed line). This means there is a relationship between average production and fishing effort. This relationship is known as the **production function** (Fig. 2, solid line). Production functions are the basis for certain important concepts used in this report: **Long-term Potential Yield** (LTPY), **Current Potential Yield** (CPY), and **Recent Average Yield** (RAY). In addition, the term **Stock Level** is employed as a biological reference for determining resource status relative to the stock level which would on average support the LTPY. Recent Average Yield is also reported in order to allow comparison of the current situation to the long-term potential.

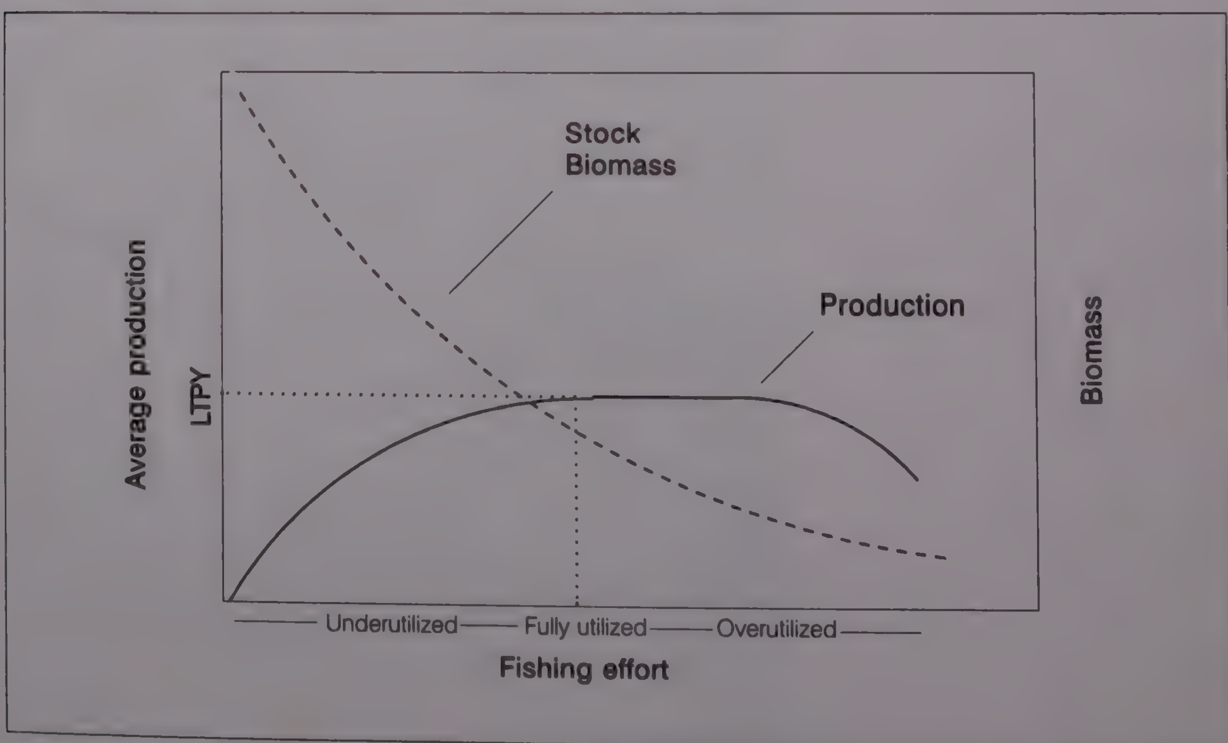

Figure 2.—Hypothetical production function. In this case, the function has a flat region where average production is insensitive to the amount of fishing effort. This occurs for many populations when the effect of growth and natural mortality on production are almost in balance. But eventually excess fishing effort reduces the size of the population to the point where production and recruitment declines precipitously.

LONG-TERM POTENTIAL YIELD (LTPY)

LTPY, or "long-term potential yield," is the maximum long-term average yield that can be achieved through conscientious stewardship, by controlling the fishing mortality rate through regulating fishing effort or total catch. LTPY is a reference point for judging the potential of the resource. However, it is not necessarily the goal of management to always take the maximum yield. Other factors may influence the choice of a management objective, such as socioeconomic considerations or conservation concerns for other resources indirectly affected by the fishery harvest. LTPY is difficult to estimate. Nevertheless, NMFS scientists have used their best professional judgment to provide these figures whenever possible.

CURRENT POTENTIAL YIELD (CPY)

CPY, the "current potential yield" (or catch) that can be taken, depends on the current abundance of fish and the prevailing production rate. It is usually estimated by applying the fishing mortality rate associated with LTPY (e.g., target fishing effort) to the current population size. This yield may be either greater than or less than LTPY. CPY is the amount of catch that will maintain the present population level (biomass) or, for overutilized stocks, stimulate a trend toward recovery to a population size that will produce the LTPY. For underutilized stocks at high biomass levels, the CPY may be larger than the LTPY. In this circumstance a large fishery harvest would not be sustainable in the long run, but it would bring the stock down to the level supporting LTPY. CPY is also difficult to estimate, and NMFS scientists have used their best professional judgment here as well.

RECENT AVERAGE YIELD (RAY)

To document the actual fishery catches, this report employs the term "recent average yield." This is the reported fishery landings averaged for the most recent three-year period, 1990-92.

STOCK LEVEL

To further clarify resource status, stock level (i.e., abundance) in 1992 is compared with the level of abundance which on average would support the LTPY harvest. This is expressed as **Near**, **Below**, or **Above** the LTPY stock level. In some cases, heavy fishing in the past reduced a stock to a low abundance, and even if the stock is currently only lightly harvested, it may take many years for it to rebuild.

EVALUATING FISHERY RESOURCE LEVELS

To evaluate the level of use of a fishery resource (i.e., underutilized, overutilized, or fully utilized), we must see how the existing fishing effort and stock abundance compares with those levels necessary to achieve LTPY.

For many stocks, LTPY or CPY may be unknown. For the purpose of reporting total LTPY and CPY across resources within the various fishery units and for the Nation as a whole, if CPY were unknown RAY was substituted when calculating a unit, regional, or national total CPY. If LTPY were unknown CPY was substituted, or, failing that, RAY was substituted in calculating totals.

In this report, the classification of fisheries as underutilized, fully utilized or overutilized is made by comparing recent fishing mortality to the level associated with LTPY. This differs from the evaluation of a fishery required under the MFCMA and the accompanying guidelines for preparations of Fishery Management Plans. Each management plan contains a specific definition of overfishing which is used for management purposes. The MFCMA national standards require management plans to be designed to give the highest continuing yield possible as modified by social and economic factors. In practice, this means each management plan may have different goals and hence different definitions of overfishing. As this report is intended to provide a broad overview across all fisheries, we use the more comparable measures of fishery conditions described below. These characterizations with respect to recent stock levels and fishing effort are in no way intended to supplant the specific definitions used to trigger management actions contained in fishery management plans.

A fishery resource is defined as **fully utilized** when the amount of fishing effort used is about equal to the amount needed to achieve LTPY and where the resource is near its LTPY stock level (e.g., menhaden and butterfish in Unit 10). For fully utilized fisheries, the RAY and CPY are usually about equal. In most cases, LTPY and CPY are also about equal, but they may differ as a result of production variability. A fishery resource is considered **overutilized** when more fishing effort is employed than is necessary to achieve LTPY. When RAY is greater than CPY, and CPY is less than LTPY, overutilization is indicated. If stock abundance is near the level that on average produces LTPY, RAY may be greater than LTPY for an overutilized stock, implying that recent landings levels cannot be sustained (e.g., Atlantic cod in Unit 1). If stock abundance is below the level associated with LTPY, RAY will likely be less than LTPY (e.g., Gulf red snapper in Unit 8).

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Additionally, it is possible for RAY, CPY, and LTPY to be about equal while the fishery resource is overutilized (e.g., Gulf shrimp in Unit 11). This occurs when reducing fishing effort would have little effect on the amount of catch realized. In such cases, overutilization may not have an apparent adverse effect on production, but it further reduces the size of the population, it wastes effort and economic resources, and imposes other deleterious consequences (e.g., excessive bycatch, gear interactions).

A fishery resource is classified as **underutilized** when more fishing effort is required to achieve LTPY. This situation is generally indicated when RAY is less than CPY and CPY is greater than LTPY while stock level is above the reference level that on average produces LTPY (e.g., Atlantic mackerel in Unit 2). But there may be exceptions. For example, RAY may be held below CPY and LTPY by management to compensate for uncertainty in population estimates (e.g., most Bering Sea groundfish in Unit 19).

These are the major factors NMFS considers for determining the status of resource utilization for this report, but they do not give a complete picture. In cases where knowledge about the stock is incomplete or when comparing LTPY, CPY, RAY, and stock level gives ambiguous results, the classification of a fishery's status is based on the best scientific judgment of the NMFS staff that conducts research on the stock in question.

In many of the fishery units, a dollar figure is given for the ex-vessel revenue generated by the commercial fishery on a given stock or group of stocks. **Ex-vessel revenue** is defined as the quantity of fish landed by commercial fishermen multiplied by the average price received by them at the first point of sale. As such, ex-vessel revenue captures the immediate value of the commercial harvest, but does not reflect subsequent revenues earned by seafood processors, distributors, or retailers. However, when ex-vessel revenue is multiplied with population LTPY, it is possible to generate estimates of **Long-term Potential Revenue** (LTPR) for a fishery on a national or regional basis. The estimates of LTPR discussed later are not a true measure of other components such as the "economic value" of the recreational catch, which is difficult to derive. Although LTPR takes both recreational and commercial catches and multiplies them by an average commercial price estimate to arrive at a baseline (relative measure) of economic significance among various user groups, it will underestimate those fisheries where there is a large recreational component. Nevertheless, LTPR serves as a useful gauge of the economic benefit generated over many disparate stocks, fisheries, and regions.

This document also reports on marine mammals and sea turtles. The same scientific principles apply to the population dynamics of these protected species, but the terminology of underutilized, fully utilized, and overutilized does not apply. Instead, marine mammals are referred to as **Depleted** when their population size is below the level of **maximum net production**. This is often referred to as their "**optimum sustainable population level**" (in the MMPA this is defined as a population size between the largest supportable within the ecosystem and the level where productivity is at a maximum, i.e. to the right of the maximum on Figure 2). Protected marine mammals and turtles may also be classified as threatened or endangered under the ESA. A species is considered threatened if it is likely to become an endangered species in the foreseeable future throughout a significant portion of its range. A species is considered endangered if it is in danger of extinction throughout a significant portion of its range. In addition to some marine mammals and all sea turtles, several Pacific salmon stocks are now listed as threatened or endangered under the ESA (e.g., Sacramento River winter run chinook salmon are threatened and Snake River sockeye salmon are endangered, Unit 12).

NATIONAL OVERVIEW: STATUS AND POTENTIAL OF U.S. LIVING MARINE RESOURCES

INTRODUCTION

The LTPY of all fishery resources fished by the United States (Table 1) is estimated at 9.5 million metric tons (t). The Food and Agriculture Organization of the United Nations (FAO) estimates the limit of the world's annually sustainable yield of marine and freshwater fish at about 100 million t. Therefore, the long-term potential harvest from all fisheries involving the United States exceeds 9% of the total world potential. LTPY includes not only fishery resources within the U.S. EEZ but also transboundary stocks off U.S. coasts and fishery resources exploited by the United States on the high seas and in the EEZ's of other nations (e.g., the South Pacific tuna fishery). Therefore, the potential yield obtainable from good management practices would not accrue solely to the United States.

LTPY and CPY cannot simply be divided between U.S. and foreign fisheries because as abundance changes, the U.S. share may change disproportionately. However, if the LTPY was prorated between the United States and foreign countries based on recent shares of the reported U.S. catch, the "prorated U.S. LTPY" would be about 7.4 million t, or 78% of the total LTPY. Most of this difference comes from the Atlantic and Pacific highly migratory pelagic fisheries (Units 5 and 18).

The geographical distribution of the potential yield (Appendix 5) shows that the Alaska region dominates in the tonnage that could be obtained in the long term (Fig. 3). The picture is somewhat different in the long-term potential revenue of the fisheries (both foreign and domestic) derived from the total LTPY, due to the difference in prices received for different species. Figure 3 indicates the approximate ex-vessel revenue if all fisheries were harvested at their LTPY level. This estimate assumes that the current commercial price at first sale could be maintained and that it can also be applied to sport-caught fish. The total revenue across all regions is estimated at $9.6 billion (this figure does not include the U.S. nearshore fisheries in Unit 21 for lack of data). This year's estimate is substantially higher (+48%) due to the

Table 1.—Recent average, current potential, and long-term potential yields of U.S. LMR's in metric tons (t). LTPY, CPY, and RAY are reported for the entire stock inside and outside U.S. waters and U.S. LPTY (prorated) and RAY are also given. Where actual LTPY is unknown, CPY is substituted; where CPY is unknown, RAY is substituted.

Unit and fishery	LTPY	CPY	RAY	Prorated U.S. LTPY	U.S. RAY
1. Northeast demersal[1]	508,621	414,221	227,721	378,806	169,600
2. Northeast pelagic[1]	470,000	640,000	168,300	395,157	141,500
3. Atlantic anadromous	3,870	3,870	3,870	3,870	3,870
4. Northeast invertebrate[1]	100,200	104,700	106,900	94,670	101,000
5. Atlantic highly migratory pelagic[1]	246,919	223,455	228,955	19,200	15,950
6. Atlantic sharks	9,730	7,630	9,530	9,730	9,530
7. Atlantic/Gulf of Mexico coastal migratory pelagic	28,069	20,093	15,887	28,069	15,887
8. Atlantic/Gulf of Mexico/ Caribbean reef fish	48,054[2]	34,677[3]	35,185	48,054[2]	35,185
9. Southeast drum and croaker	75,815[2]	25,689[3]	25,689	75,815[2]	25,689
10. Southeast menhaden and butterfish	1,166,500	886,500	879,700	1,166,500	879,700
11. Southeast/Caribbean invertebrate	126,656	120,732	121,574	126,656	121,574
12. Pacific coast salmon[4]	43,366	43,366	30,324	43,366	30,324
13. Alaska salmon	282,200	282,200	321,500	282,200	321,500
14. Pacific coast and Alaska pelagic	564,000	184,000	99,000	564,000	99,000
15. Pacific coast groundfish[1]	328,400	273,840	370,954	249,441	281,763
16. Western Pacific invertebrate	120	0	220	120	220
17. Western Pacific bottomfish and armorhead	2,812	701	443	2,812	443
18. Pacific highly migratory pelagic[1]	1,798,820	1,718,233	1,707,299	261,395	248,096
19. Alaska groundfish total[1]	3,375,300	3,192,305	1,925,530	3,372,600	1,920,830
(Eastern Bering Sea)[5]	(2,903,923)	(2,423,298)	(1,664,710)	(2,903,923)	(1,664,710)
(Gulf of Alaska)[5]	(451,377)	(735,507)	(225,120)	(451,377)	(225,120)
(Pacific halibut)[1, 5]	(20,000)	(33,500)	(35,700)	(17,300)	(31,000)
20. Alaska shellfish	95,370	127,320	127,051	95,370	127,051
21. U.S. nearshore resources	221,683	221,683	221,683	221,683	221,863
Total	9,496,505	8,525,215	6,627,315	7,439,514	4,770,395
Percent of LTPY or prorated U.S. LTPY		90%	70%		64%

[1]Includes some transboundary stocks so LTPY may not accrue solely to the U.S. LTPY and RAY from U.S. share are shown where applicable.
[2]Underestimate.
[3]Overestimate.
[4]Approximate yield in weight, converting from average fish weight taken in the fishery. Actual catch reported in numbers only. See unit synopsis.
[5]Subtotal of Unit 19.

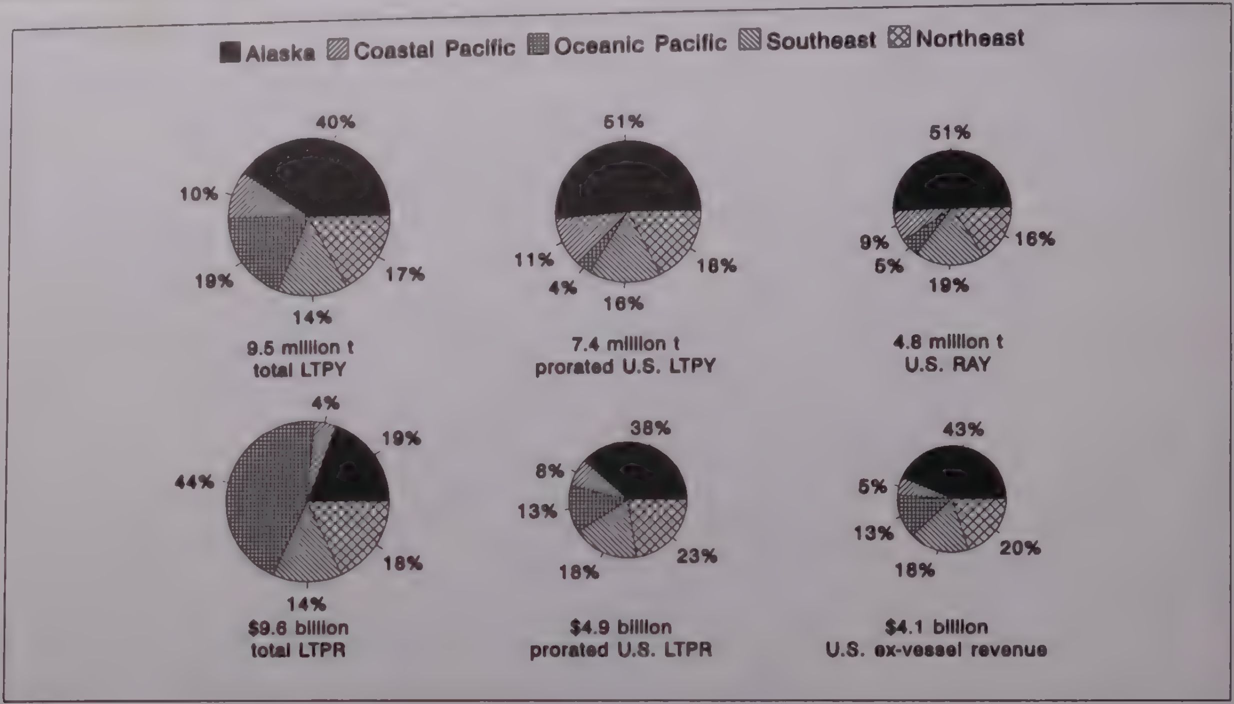

Figure 3.—Long-term potential yield (LTPY) and ex-vessel revenue (LTPR) by region, as percent of category. Information is provided for entire fishery units, along with the prorated U.S. shares. Prorations are calculated by the percentage of U.S. share of the recent average yield (or catch).

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addition of new fishery value (e.g., bigeye tuna in Unit 18) and updates of previously reported ex-vessel revenues (e.g., Pacific salmon in Unit 13) in 1992. The Alaska region has the highest prorated U.S. revenue (Fig. 3). Both prorated U.S. LTPY and LTPR are shown in Figure 3, as are the U.S. share of RAY and its recent ex-vessel revenue estimate. Note again, however, that several important stocks are distributed across international borders and are shared with other fishing nations. The transboundary nature of the valuable highly migratory pelagic species in the Atlantic and Pacific are indicated by the large differences between the total and prorated U.S. estimates of yield and revenue.

The estimate of the prorated U.S. CPY is 6.6 million t or 88% of the prorated U.S. LTPY. There are, however, important differences among regions, species groups, and individual stocks. For example, the prorated U.S. LTPY exceeds the prorated U.S. CPY by about 30% or more for Atlantic coastal pelagics (Unit 7), southeast drums and reef fish (Units 8 and 9), and Pacific coast pelagics (Unit 14). This indicates that some of the stocks in these units are at low levels and will need to be rebuilt before their potential can be realized (e.g., western Pacific bottomfish in Unit 17). Prorated U.S. CPY exceeds prorated U.S. LTPY by substantial amounts for northeast pelagics and invertebrates (Units 2 and 4) and some Alaska groundfish and Pacific halibut (Unit 19), indicating that those stocks are currently above the level which would result in LTPY. In other units, CPY and LTPY are similar. Unfortunately, for some fisheries either CPY or LTPY or both have not yet been estimated, and their status can only be approximated (e.g., Units 8 and 21).

The total RAY, including recreationally-caught fish and fish from transboundary stocks landed by other nations, is 6.6 million t. The U.S. RAY is estimated at 4.8 million t or about 64% of the prorated U.S. LTPY (Table 1). This is somewhat higher than the catch reported in the NMFS publication "Fisheries of the United States." Some landings information obtained by NMFS scientists and included here may be unreported in "Fisheries of the United States." RAY (combined commercial and recreational catches) from the fisheries involving the United States is just under 5% of the world catch. In recent years, the United States has ranked sixth among major fishing nations, following China, the former Soviet Union, Japan, Peru, and Chile.

The 1992 recreational marine finfish catch (including catch and release) off the Atlantic and Gulf coasts was estimated at 285.5 million fish, of which 144.2 million fish or 105,688 t was retained. In 1989 (the last year for which data are available), the West coast recreational catch was estimated at 41 million fish or 13,000 t. This catch total is exclusive of Pacific salmon, which historically has composed about 25% of the entire West coast recreational catch.

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The primary requirement for increasing U.S. fisheries to their LTPY is to rebuild stocks that have been overutilized. Figure 4 summarizes the regional status of utilization for 231 LMR species and/or species groups. Figure 5 shows, by region, the estimated current stock levels relative to the level needed to support LTPY. Across all regions, for those stock groups where the status is known, 40% are overutilized and 42% are below the stock level necessary to support LTPY (Fig. 6). Rebuilding these stocks would bring fishery RAY's substantially closer to LTPY.

There are also many cases of fully utilized stocks (43% where the status is known) where stock abundance is near the level that produces LTPY (45% where the level is known, Fig. 6). These stocks need to be maintained in healthy condition. The underutilized stocks currently at a high stock level (17% underutilized and 13% above level needed for LTPY where known, Fig. 6), could be fished harder to produce their long-term potential. But, several factors should be considered when increasing fishing pressure on these underutilized stocks:

1) Estimates of LTPY and CPY are sometimes imprecise; therefore, harvest levels may be set conservatively to reduce the risk of depleting fishery resources.

2) Increasing the yield will result in a reduction in abundance, catch rates, and size of fish, which may adversely affect some users of the resource (e.g., anglers who desire a high catch rate and/or large fish).

3) There are limited markets for increased landings of several species for which RAY is less than CPY and LTPY (e.g., dogfish off New England and arrowtooth flounder off Alaska).

4) Increasing the yield may be uneconomical in terms of efficient utilization of investment resources.

Brief regional summaries of potential yields and the status of fisheries resources, as well as marine mammals and sea turtles, are given below.

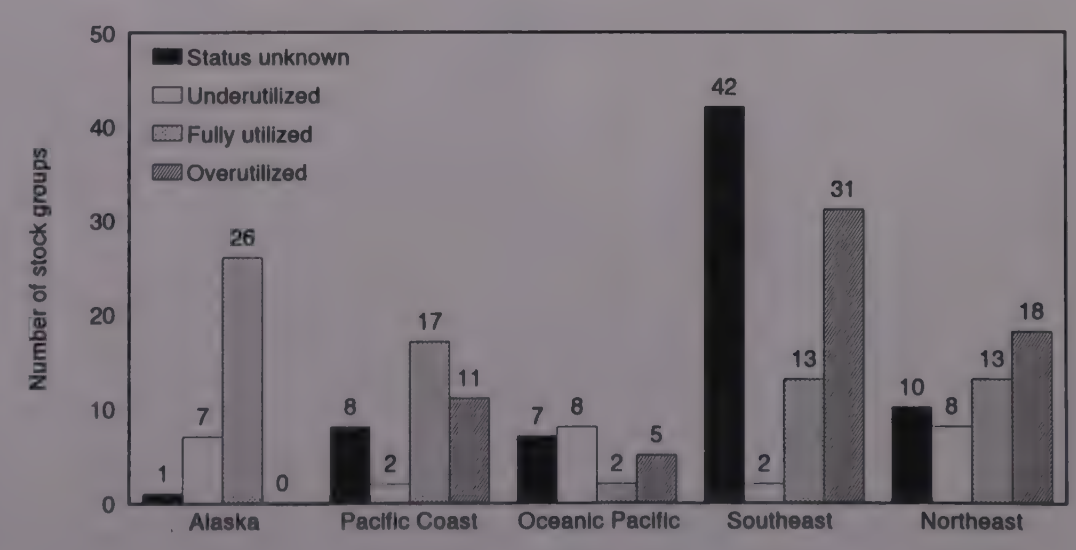


Figure 4.—Utilization of U.S. living marine resources by region. Numbers at the top of each bar indicate the number of stocks in that category.

NORTHEAST U.S. LMR'S

Averaged over the three-year period ending in 1992, the fisheries of the Northeast region (Appendix 5) contributed about 20% of the prorated U.S. recent ex-vessel revenue and 16% of the volume (i.e., U.S. RAY) of the Nation's commercial fisheries (Fig. 3). Total 1992 landings of all species in the northeast were 769,667 t, with an estimated ex-vessel revenue of $818 million. The mixed-species groundfish fishery is the most valuable fishery of the region ($188 million), followed by American lobster ($161 million) and Atlantic sea scallop ($152

Figure 5.—Stock levels relative to the level needed to support LTPY. The numbers at the top of each bar are the number of stocks in that category.

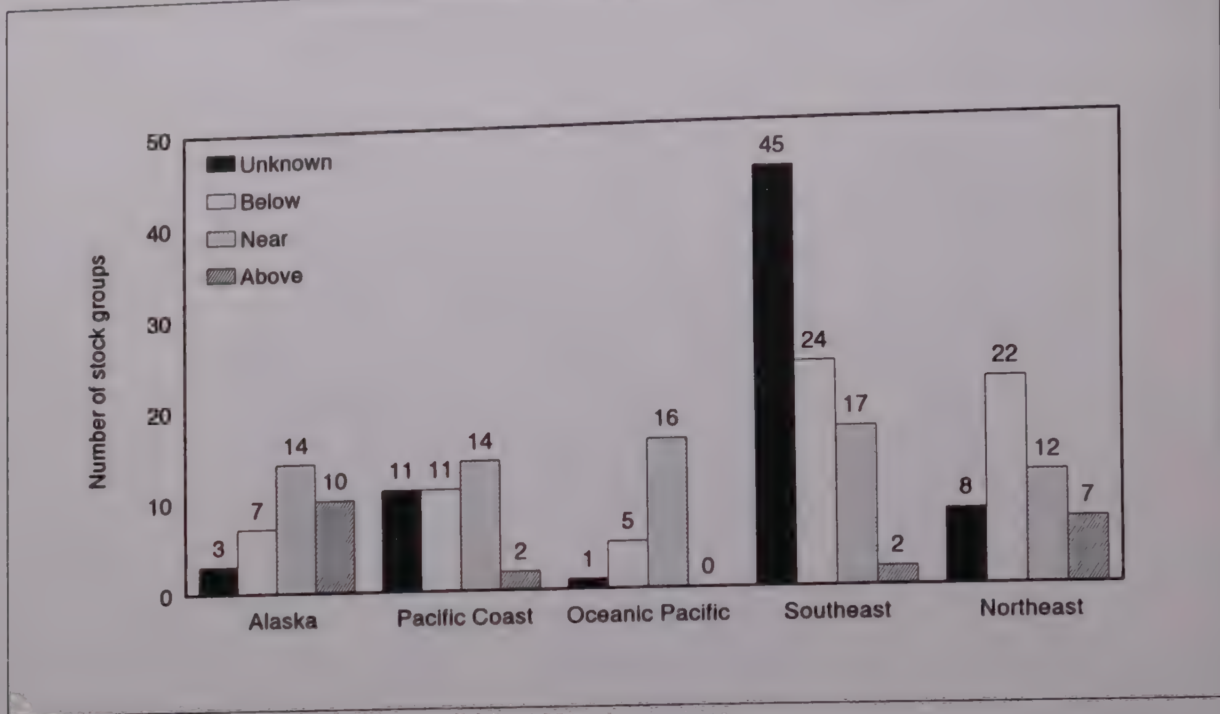
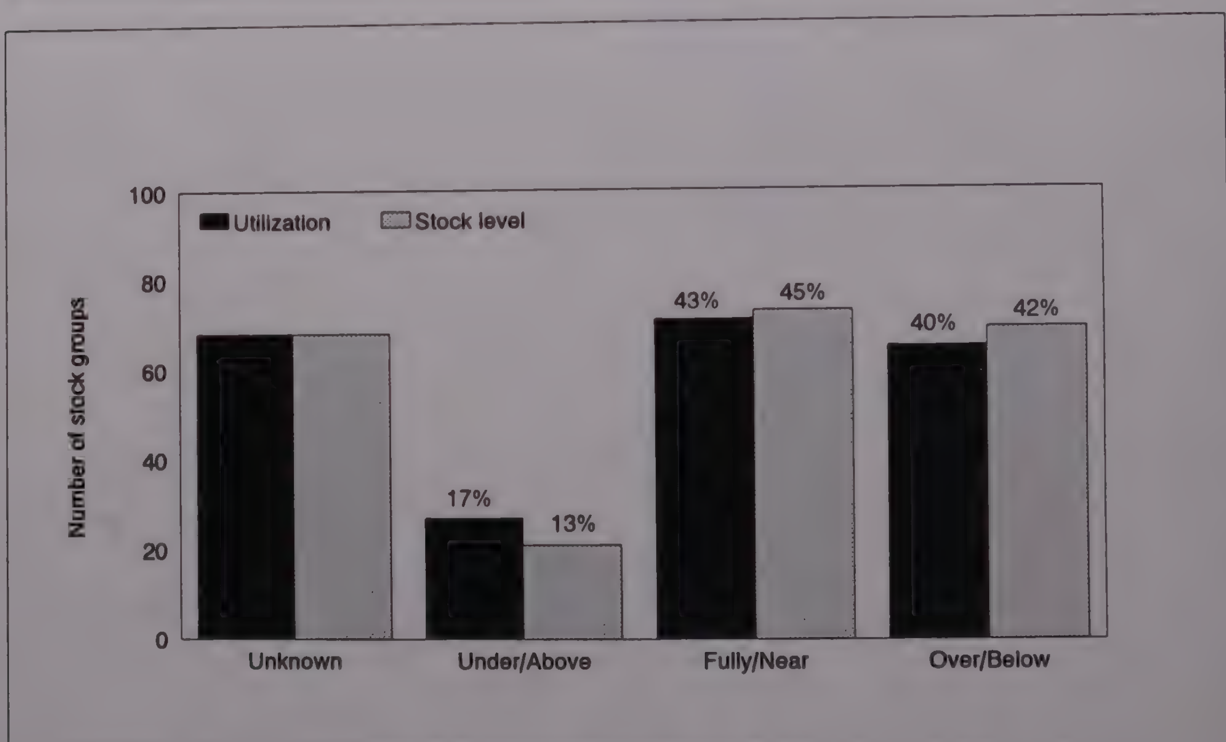


Figure 6.—Status of U.S. living marine resources for all regions combined. Utilization and stock level relative to the level needed to support LTPY are given for all stocks including nearshore resources. The bars represent the number of stocks, and the figures given at the top of each bar are the percent of the stocks for which the status is known in that category of utilization or stock level.



. . . NORTHEAST U.S. LMR'S

million). Recreational fisheries for species such as cod, winter flounder, mackerel, striped bass, bluefish, and bluefin tuna are extremely important and contribute greatly to the region's economy. There were approximately 19 million recreational marine fishing trips in 1992 which produced landings of over 100 million fish.

Northeast finfish and invertebrate fisheries have an estimated LTPY of over 1.3 million t (including very nearshore resources such as menhaden, blue crab, oyster, blue mussel, hard clam, etc.), or 18% of the national LTPY. Recent annual landings of northeast resources have only totaled about 769,600 t—about half of their long-term potential. The discrepancy between recent landings and potential production results from significant overutilization of 18 stocks in the region (including principal groundfish, flounders, and others) and underutilization of 8 stocks. Stocks of Atlantic mackerel and herring are both underutilized at present and collectively could produce an additional 200,000 t of long-term potential yield. Thirteen species or stocks are fully utilized.

The mixed-species groundfish fishery may benefit from the recent passage by the NEFMC of Amendment 5 to the FMP for the Northeast Multispecies Fishery. This Amendment, recently approved by the

... NORTHEAST U.S. LMR'S

Secretary of Commerce, will limit effort by commercial fishing on groundfish in New England and also prevent the issuance of new vessel permits in this overcapitalized fishery. Several overutilized New England groundfish stocks are landed by both Canada and the United States, but Canada has recently placed severe restrictions on its fishery to promote stock rebuilding.

A new amendment (Amendment 4) to the sea scallop FMP has also been prepared by the NEFMC. Now approved, it will control fishing effort by limiting the days at sea for each vessel and placing a moratorium on new entrants. Along with supplementary measures, it is intended to reduce fishing mortality and move this fishery from overutilization to full utilization.

SOUTHEAST U.S. LMR'S

The combined U.S. LTPY for southeast Atlantic, Gulf of Mexico, and Caribbean LMR's is estimated at about 1.2 million t (16% of the U.S. LTPY); recent catches have run about 99% of CPY and 76% of LTPY. Atlantic swordfish and bluefin tuna, many southeast Atlantic snappers and groupers, and Caribbean reef fish have been overutilized, and some stocks are at historically low levels. The status of many other reef fish stocks is unknown, but they are likely to be overutilized as well. Individually, these stocks are minor portions of the catch, but, in aggregate, they have supported important recreational and commercial fisheries. The recreationally and commercially important coastal pelagic species (e.g., mackerels, dolphin fish, and cobia) yield only about 56% of their estimated aggregate LTPY as a result of overutilization. Certain individual stocks are severely depressed (e.g., Gulf of Mexico king mackerel). The impact of Mexican fisheries on these stocks is not well known but may affect stock rebuilding efforts.

Currently, all commercially important shrimp species are producing about their LTPY level, but these fisheries are overcapitalized, and could produce similar yields with considerably less effort if fishing mortality were reduced. Therefore they are classified as overutilized. An important consequence of excessive fishing mortality on shrimp is excessive bycatch, which adversely impacts finfish stocks. The dominant catches are Gulf of Mexico brown, white, and pink shrimp, which represent 89% of the total U.S. shrimp catch. In 1991, those three species produced a total catch of 104,361 t, valued in excess of $400 million.

WEST COAST AND WESTERN PACIFIC LMR'S

West coast and Pacific island fisheries (Appendix 5) account for more than 1.1 million t and 15% of the U.S. LTPY. These include fisheries for tuna, billfish, and swordfish (Pacific-wide); reef and seamount finfish and lobster (Pacific islands); and U.S. West coast groundfish, salmon, coastal pelagic fishes, and the very nearshore species. Management plans for stocks in Federal waters are primarily developed by the Pacific Fisheries Management Council (PFMC) and the Western Pacific Fisheries Management Council (WPFMC), which may co-manage with or defer responsibility to state agencies, tribal fisheries agencies, or international groups.

Pacific-wide commercial tuna fisheries, foreign and domestic, result in ex-vessel revenue estimates of about $3.6 billion, with the U.S. tuna catch worth about $522 million. Commercial ex-vessel revenues for Pacific salmon and groundfish are $140 million and $78 million, respectively. In addition, though more difficult to quantify, the value of the recreational fisheries for these stocks is substantial.

On the Pacific coast, including nearshore resources, most of the stocks are fully utilized or overutilized, with only two of 38 stocks classified as underutilized (Fig. 4). In the oceanic Pacific, eight of the 22 stocks are underutilized while the status of seven others is unknown.

Salmon (Unit 12) have long been part of the cultural heritage of the Pacific Northwest and have supported important commercial and recreational fisheries in Washington, Oregon, and California. All five species (chinook, coho, sockeye, pink, and chum) are considered overutilized in the region. Loss of spawning habitats seems to be the main cause of salmon decline, and because of excess fishing capacity, strict fishing limitations are now needed to protect the stocks. Management is very complex, involving many stocks

. . . WEST COAST AND WESTERN PACIFIC LMR'S

that originate from various rivers and under several management jurisdictions. Chinook and coho salmon are managed by a Federal fishery management plan, while sockeye, pink, and chum salmon are managed primarily by the bilateral Pacific Salmon Commission and state and tribal fishery agencies.

Coastal pelagic fishes (Unit 14) provide food, bait, and industrial fishery products along the Pacific coast. All are fully utilized except jack mackerel, one of the few underutilized West coast species. The Pacific sardine population has been increasing after decades at low abundance levels.

The multispecies, multigear groundfish fishery (Unit 15) harvests a vast array of flatfishes, rockfishes, and other bottom-dwelling species along the Pacific coast. Management is complex because many different species may be harvested together, but not all have the same response to fishing pressure. Pacific whiting dominates the commercial catch, accounting for about 77% of the 370,954 t of groundfish landed as the 1990-92 average. Rockfishes and lingcod also support popular recreational fisheries. Certain stocks, such as Pacific ocean perch, need to be rebuilt following overutilization and a period of poor recruitment. The shortbelly rockfish is the only underutilized groundfish.

Of the western Pacific invertebrate fisheries regulated by the WPFMC (Unit 16), the spiny and slipper lobster fishery is the most valuable, but landings and effort have dropped substantially since 1989 and the fishery was closed in 1993 to allow rebuilding of these stocks.

Western Pacific bottomfishes (Unit 17) are harvested from a variety of rock and coral habitats around Hawaii and the western Pacific. The group is managed jointly by the WPFMC, the U.S. Trust Territories, the Commonwealth of the Northern Marianas Islands, and the State of Hawaii.

The highly migratory stocks (Unit 18)—tunas, billfishes, swordfish, sharks, and others—range the high seas, often beyond U.S. fisheries management jurisdiction. These stocks represent the largest non-U.S. share of the total estimated LTPY and RAY (Fig. 3). International cooperation and consensus on a Pacific-wide plan to obtain fishery statistics and other vital data for accurate stock assessments are needed for effective ocean-wide management of tropical tunas and other highly migratory pelagic fishes.

ALASKA LMR'S

The Alaska region is one of the most productive areas of the world's oceans, supporting large populations of salmon, groundfish, crabs, marine mammals, and seabirds. Alaska's fisheries are grouped under salmon (Unit 13), groundfish (Unit 19), shellfish (Unit 20), and herring (incorporated in Unit 14). Fishing holds a place as a tradition and heritage in Alaska. It contributes significantly to the recreation, food supply, and economy of Alaska; helps reduce the Nation's trade deficit; and is the largest nongovernment employer in the state. Alaska's combined LTPY of economically important species is almost 3.8 million t. The resources are generally in healthy condition with CPY only 5% below the LTPY. The RAY has been steady at about 2.4 million t, or 66% of the combined CPY. However, the extra yield potential cannot yet be fully utilized. This is because the harvest has been conservatively managed to offset lack of data and scientific uncertainty, and is now managed for additional objectives which include economic, bycatch, and protected species considerations. The 1992 ex-vessel revenue for all of Alaska's LMR's totaled more than $1.185 billion ($155 million for salmon, $725 million for groundfish, and $305 million for shellfish). The value of the fisheries products exported from the state of Alaska in 1992 was $1.884 billion. In addition, the state of Washington exported $652 million in fisheries products in 1992, some of which were harvested in Alaska waters.

Alaska salmon stocks have produced bumper harvests in recent years. The RAY of 321,500 t is 13% above CPY and LTPY. The ex-vessel revenue from the 1992 catch was $155 million. Five species of Pacific salmon contribute to this catch. Sockeye salmon is the most valuable, and in recent years its catch has been the largest of the five species, followed closely by pink salmon.

The development of groundfish fisheries

ALASKA LMR'S

off Alaska is perhaps the greatest success story of the MFCMA. Up to the time of implementation of the MFCMA in 1977, the groundfish fisheries off Alaska, except for the domestic Pacific halibut catch, were totally dominated by foreign fishing. Within a few years, the U.S. domestic fishery replaced the foreign fisheries. For the Bering Sea/Aleutian Islands region, the average 1990-92 groundfish catch was about 1.66 million t with ex-vessel revenue in 1992 in excess of $522 million. For the Gulf of Alaska, the average 1990-92 groundfish catch was 225,100 t, which generated ex-vessel revenues of $133 million in 1992.

For the Bering Sea/Aleutian Islands region, the major species groups harvested are walleye pollock, Pacific cod, flatfishes, Atka mackerel, rockfish, and sablefish. Except for Greenland turbot, all the groundfish are high in abundance and in excellent condition. Walleye pollock and Pacific cod abundances are much lower than their recent high levels, but are still close to the levels that would produce LTPY.

In the Gulf of Alaska the major species groups harvested are walleye pollock, Pacific cod, sablefish, flatfishes, and slope rockfish. Overall abundance of groundfish in the Gulf has been relatively stable, except for the walleye pollock fishery. Recent yields of other fisheries are substantially below CPY, indicating the resources are underutilized, largely because of continued high abundance of Pacific cod and flatfishes.

In addition to the general groundfish complex, Pacific halibut is a groundfish species that has supported an important traditional fishery for the United States and Canada. This resource is fully utilized and managed by the International Pacific Halibut Commission. The resource is generally in good condition with recent U.S. catches averaging 31,000 t worth $70 million ex-vessel.

The king and Tanner (or snow) crab fisheries are currently the most important shellfish fisheries in Alaska. King crab landings are less than half the LTPY due to low stock levels. Tanner crab landings are more than double the LTPY owing to very high stock levels. Total 1992 crab catches were worth $305 million, with one-fourth of this due to king crabs and the rest to Tanner crabs.

Spotted dolphin

U.S. NEARSHORE LMR'S

It is difficult to assess the status of all nearshore species (Unit 21) around the entire U.S. coast because they come under varied management and data collection regimes. No firm estimates exist for LTPY or CPY because of the diverse nature of these coastal and estuarine species and their fisheries. Management authority is typically a regional, state, and/or local responsibility because most fisheries occur within the three-mile interior boundary to the Federally-controlled EEZ. But, generally, Atlantic oysters, hard and softshell clams, bay scallops, and abalones are overutilized, at least in part of their ranges. Fully utilized resources include Pacific shrimp and clams, Dungeness crab, blue crab, and calico scallop. The status of 20 of the 36 stocks included in this unit cannot be determined from the existing data. The1990-92 averaged RAY is conservatively estimated at 221,683 t. The commercial ex-vessel revenue from all nearshore resources is about $376 million, which does not include the substantial recreational component.

MARINE MAMMALS AND SEA TURTLES

The MMPA and ESA require regular status updates for marine mammal and sea turtle populations. The current state of our knowledge allows only 25 of 150 populations or stocks to be assigned abundance trend estimates (Table 2). The rest are of unknown status (particularly the Atlantic and Pacific dolphin and porpoise stocks). The increase in the number of stocks reported in Table 2 over prior years is due to the breakout of regional stocks for many species. Previous editions of "Our Living Oceans" had lumped these regional stocks under single species headings.

Table 2.—Status and trends of marine mammals and sea turtle stocks.

Unit	Stock Trend					ESA/MMPA Status
	Unknown	Increasing	Decreasing	Stable	Total	E/T/D[1]
22. Atlantic marine mammals	50	2	1	0	53	7/0/1
23. Pacific marine mammals	70	9	5	2	86	11/2/3
24. Sea turtles	5	2	1	3	11	6/5/0
Total	125	13	7	5	150	24/7/4
Pecent of total	83%	9%	5%	3%		

[1]E=Endangered, T=Threatened, D=Depleted.

Marine Mammals

At least 35 species of marine mammals range the western North Atlantic Ocean and the Gulf of Mexico, including 32 species of whales, dolphins, and porpoises, two seal species (harbor and gray seals), and the West Indian manatee. Unit 22 considers 53 species stocks, but only simple abundance estimates are known for 20 stocks. Of these, seven species found off the east coast and Gulf of Mexico are listed as endangered under ESA (i.e., sei, sperm, blue, fin, humpback, North Atlantic right whales, and West Indian manatee). Also, following a 1987-88 mass die-off, there is serious concern about the status of coastal and offshore bottlenose dolphins in the Mid-Atlantic.

There are far too few data on other stocks to evaluate their status. Abundance trends are known for only the northeast stock of harbor seal, gray seal, and the manatee (Table 2).

At least 50 marine mammal species (Unit 23) occur in U.S. waters of the eastern North Pacific Ocean and eastern tropical Pacific, including 36 species of whales, dolphins, and porpoises, 11 species of seals and sea lions, walrus, polar bear, and sea otter. Simple abundance estimates are known for 73 stocks. Of these, nine species are listed as endangered or threatened under ESA guidelines. Although the data are incomplete, right whales in the eastern North Pacific are at critically low levels and nearly extinct; only 5-7 sightings have been made in the past 25 years. The eastern North Pacific or "California" stock of gray whales is believed to have recovered to 21,000 animals, near to or surpassing its historical abundance level. Moreover, south of Alaska some marine mammals

. . . Marine Mammals

have also recovered or are recovering to near historical abundance levels (i.e., California sea lion and the northern elephant seal). As with the Atlantic species, data are insufficient to assess the status of most Pacific whales, dolphins, and porpoises, and abundance trends are known for only 16 stocks (Table 2).

Sea Turtles

Six species of sea turtles (Unit 24) regularly spend all or part of their lives off the U.S. Atlantic and Pacific coasts, and in U.S. territorial waters of the Caribbean and western Pacific Ocean: The Kemp's ridley, olive ridley (Pacific only), loggerhead, green, hawksbill, and leatherback. Limited assessment data for 11 stocks exist for about half of the turtle species in U.S. waters, but studies of nesting densities provide a partial picture of population trends. The Kemp's ridley population has experienced a major decline since 1947 from an estimated 40,000 nesting females to less than 800 nests per year between 1978 and 1988. Loggerhead nesting populations have declined over the last 20-30 years in the northern portion of their range (e.g., Georgia and South Carolina). On the Atlantic beaches of south Florida, however, loggerheads have not shown a decline, and might even be increasing. Green turtle nestings on Florida beaches are low, but they increased between 1971 and 1989. Leatherbacks nest on beaches of the Virgin Islands and Puerto Rico, but nesting records are too few to detect trends.

Under the Endangered Species Act, all marine turtles are listed either as endangered or threatened (Table 2). The NMFS has authority to protect and conserve marine turtles in the seas and the U.S. Fish and Wildlife Service maintains authority while turtles are on land. The Kemp's ridley, hawksbill, and leatherback turtles are listed as endangered throughout their ranges. The loggerhead and olive ridley turtles are listed as threatened throughout their U.S. ranges, as is the green turtle, except the Florida nesting population which is listed as endangered.

INTRODUCTION

The management of living marine resources is extremely complex and involves many biological, economic, social, and political factors. Each region and each fishery discussed in this report, and even those fisheries that are currently well managed and yielding near their long-term potential for the Nation's benefit, must continually adjust and adapt to ever changing conditions which can undermine management. If the Nation is to increase the long-term benefits from currently overutilized and depleted resources, we must confront the difficult issues and practices which have resulted in overutilization and resource depletion.

In each of the 24 fishery unit reports, major issues affecting the resource and its management are discussed. Although each fishery unit has unique features, there are common themes that are significant to many, if not all, units. These can be summarized under eight headings: Management Concerns, Bycatch and Multispecies Interactions, Resource Allocation, Jurisdiction and Transboundary Issues, Habitat Concerns, Underutilized Species, Recovery of Protected Species, and Scientific Information and the Adequacy of Assessments. These issues are briefly considered here, along with recent progress made in addressing them.

MANAGEMENT CONCERNS

Ultimately, the management strategies employed must be a consideration when many fish stocks are overutilized or when populations are too low to produce the LTPY. Management is also a concern when the economic performance of a fishery is poor because there are more vessels than needed to harvest the available amount of fish (i.e., overcapitalization). Table 3 summarizes the status of utilization for each fishery unit. Some stocks are overutilized in most units (28% of all stocks and 40% of the stocks where status is known, Fig. 6). The situation is about the same with respect to the status of stock levels. The list of stocks that are overutilized and/or below the level required to produce LTPY includes some of the Nation's most valuable fishery resources, such as New England groundfish, Atlantic sea scallops, Gulf shrimp, several pelagic highly migratory stocks (including Atlantic bluefin tuna and swordfish), some Pacific salmon stocks, many nearshore stocks (including some oyster populations, bay scallops, abalones, Pacific striped bass), some rockfish stocks off Alaska, and Alaska king crab.

Many U.S. marine fisheries, including both the overutilized and fully utilized stocks, are overcapitalized. As generally understood, this means that there are more fishing vessels and gear trying to catch fish than are necessary to harvest the resource efficiently. In effect, this means that the Nation may be losing more production of other valuable goods and services than it gains from the fish being harvested by excess capital. Such overcapitalization is a major factor contributing to overutilization of a resource. Where fisheries are overcapitalized and performing poorly in economic terms, short-term economic concerns tend to receive undue weight relative to the steps needed to cut back harvests and to achieve the long-term biological and economic potential. The excess capital may maintain pressure to increase catch limits beyond potential yield levels, depleting the resource, and once depleted, preventing its recovery. Many of the other issues discussed in this report are aggravated by overcapitalization. For example, when there is an excess number of boats, fish allocation and bycatch problems are exacerbated.

Economic theory and experience in most U.S. fisheries (and worldwide), indicates that overcapitalization is an inevitable consequence of fisheries management that allows anyone who wants to participate in the fishery to do so. Only recently have U.S. fisheries managers begun to control access to fisheries (see Progress section, page 22).

Although only discussed as a major problem in a few units, economic issues are important in all the fisheries described in this report. Data for evaluating the economic performance of most of our fisheries are scarce. More economic information will be needed to improve management of our living marine resources.

Table 3.—Utilization of assessed stocks of U.S. living marine resources.

Unit and fishery	Unknown	Over	Full	Under	Total
1. Northeast demersal	2	14	6	3	25
2. Northeast pelagic			1	5	6
3. Atlantic anadromous	3[1]		2		5
4. Northeast invertebrate		2	3		5
5. Atlantic highly migratory pelagic	2	4	4		10
6. Atlantic shark	1	1	1		3
7. Atlantic/Gulf of Mexico coastal migratory pelagic	3	2	1	1	7
8. Atlantic/Gulf of Mexico/Caribbean reef fish	16	10	2		28
9. Southeast drum and croaker	4	3			7
10. Southeast menhaden and butterfish			2	1	3
11. Southeast/Caribbean invertebrate	5	8	1		14
12. Pacific coast salmon		5			5
13. Alaska salmon			5		5
14. Pacific coast and Alaska pelagic			5	1	6
15. Pacific coast groundfish	4	1	11	1	17
16. Western Pacific invertebrate		1			1
17. Western Pacific bottomfish and armorhead		2		4	6
18. Pacific highly migratory pelagic	7	2	2	4	15
19. Alaska groundfish (total)	1		16	6	23
20. Alaska shellfish			3	1	4
21. Nearshore resources	20	10	6		36
Total	68	65	71	27	231
Percent of total	29%	28%	31%	12%	
Percent of known total (163 stock groups)		40%	43%	17%	

[1]Variable by river.

BYCATCH AND MULTISPECIES INTERACTIONS

The issue of bycatch (i.e., the incidental capture of nontargeted species) and interactions between species affects most of the units in this report. The management of many LMR's, including the recovery of protected species of marine mammals and sea turtles, can potentially be undermined by their bycatch in other fisheries. For example, the recovery of depleted reef fishes in the Gulf of Mexico (Unit 8) may be slowed or prevented by bycatch of young fish in the shrimp fishery. Bycatch issues affect management decisions on the allocation of resources to user groups as well. Groundfish trawl fisheries off Alaska (Unit 19) are now restricted to reduce the bycatch of Pacific halibut and crabs. Bycatch of marine mammals and sea turtles by the commercial fisheries may need to be reduced to promote recovery of these stocks (e.g., Atlantic harbor porpoise, Unit 22).

Many others, such as the Pacific groundfish fishery (Unit 15), catch a wide variety of species on a single fishing trip. Management is complicated here because each species is affected differently by the different fishing mortality rates. Finding a management scheme which allows full utilization of a highly productive species, while protecting species with low productivity, when they are harvested together, is a major challenge.

Ecological interactions may also affect management of LMR's. Harvesting one component of an ecosystem may shift the balance towards other, less valuable, species. In the U.S. northeast, commercially important groundfish once dominated the fish biomass, but now skates and dogfish make up a much larger share (Unit 1).

RESOURCE ALLOCATION

Allocation of fish between user groups is a difficult socioeconomic problem in many fisheries. Conflicts often arise between different sectors of the commercial industry (e.g., inshore and offshore fishermen in the Bering Sea and Gulf of Alaska, Unit 19; longliners and trawlers on the Pacific coast, Unit 15), between commercial fishermen and recreational fishermen (e.g., fisheries for coastal migratory pelagics, Unit 7), and between conservation groups and "ecotourists" and fishermen (e.g., reef fish resources in the southeastern U.S.). In many cases, economic analysis may help guide allocation decisions; in others, social considerations may predominate.

. . . RESOURCE ALLOCATION

At present, it is the responsibility of Fishery Management Councils and the Federal government to resolve allocation problems. This amounts to deciding who are the "winners" or "losers," often times without objective criteria and adequate information. It may be possible to reduce the role of government in allocation decisions by allowing shares in a fishery to be traded (i.e., bought and sold) between participants. This way, private individuals can assess the value they place on participation (based on monetary and/or nonmonetary factors). Economic forces will move to allocate shares in the fishery to those who place the greatest value on participation.

This approach requires that access to the fishery be controlled (see section on management concerns), otherwise the value of everyone's shares will be dissipated by overcapitalization.

JURISDICTION AND TRANSBOUNDARY ISSUES

Many living marine resources are shared with other countries, including our immediate neighbors, Canada and Mexico. Some stocks of concern to the United States, like Atlantic salmon, migrate through the waters of more distant nations such as Greenland (Unit 3). In addition, many stocks straddle the boundaries between state and Federal waters and between state jurisdictions (Unit 21). This means that several management authorities may have overlapping responsibilities for the same resource, which include data collection, scientific analyses, and implementing management controls. State, Federal, and international agencies may be involved in the management of some resources such as Pacific halibut (Unit 19) or Atlantic and Pacific highly migratory pelagics (Units 5 and 18). The search for agreement among competing interests and various entities can slow the management process or undermine it altogether. Thus, it requires careful coordination and agreement over mutual actions to promote responsible resource use.

HABITAT CONCERNS

The productivity of a living marine resource is a function of the environmental conditions in which the species lives as well as its biological characteristics. If, for example, the quality and/or amount of habitat available to support young fish is reduced, the overall productivity of the stock will decrease, and fewer will be available for harvest. These concerns are particularly important for anadromous species such as salmon (Units 3, 12, 13) and for many of the nearshore species, because our rivers and coastal areas tend to be more affected by pollution and habitat alteration than areas further offshore. For example, Gulf shrimp (Unit 11) in the U.S. southeast are fully dependent on nearshore habitat during a critical early phase of their life cycle. Loss of estuaries and marshes could have major consequences for the shrimp resource, one of our most valuable marine fisheries.

UNDERUTILIZED SPECIES

A few abundant resources, such as pelagic stocks in the northeastern U.S. (Unit 2), are currently underutilized. A much larger fishery yield could potentially be obtained from these stocks, but market conditions or the availability of more valuable or accessible alternatives has kept the harvest low. Shifting fishing pressure from one species to another could relieve some pressure from stressed stocks and aid in rebuilding of depleted resources while reducing the adverse impact of a rebuilding period on the industry. However, underutilized fish stocks may inhabit the same areas as overutilized stocks. In this case, harvest strategies need to be developed so that the former can be utilized without jeopardizing the latter.

RECOVERY OF PROTECTED SPECIES

Many protected marine mammal and sea turtle stocks are listed as endangered or threatened under the ESA and/or depleted under the MMPA. Developing and implementing management strategies to minimize the adverse impact of human activities on these animals and encourage their recovery, while not unnecessarily restricting commercial and recreational fisheries, is a major challenge.

SCIENTIFIC INFORMATION AND ADEQUACY OF ASSESSMENTS

There is a good scientific basis for assessing the status of most of the major species harvested in each region. Nevertheless, the status of utilization is unknown for about 29% (Fig. 6, Table 3) of the fish species or groups considered in this report. The recent population size relative to the stock level that would produce LTPY is also unknown for 29% (Fig. 6). The trend in abundance is unknown for 83% (Table 2) of the marine mammal and sea turtle stocks. Many of the stocks whose status is unknown (Unit 8) may have relatively small potential yields compared to major species such as walleye (Alaska) pollock or Atlantic cod, however, important fisheries still focus on these species. Even for the stocks included in Table 3 where the status or trend in abundance is known, the information is often imprecise. This is usually because of the difficulties of sampling catches and surveying over large areas for many species. Even when new sampling programs have been implemented in recent years, the lack of historical data complicates the estimation of population status and trends. There are also large gaps in fundamental understanding of the structure and dynamics of LMR populations and the ecosystems of which they are a part.

Many potential benefits from LMR's may not be achieved because of insufficient information. When the status of LMR's is unknown or imprecisely known, it is necessary to harvest conservatively to guard against accidental depletion. The groundfish fisheries in the eastern Bering Sea and Gulf of Alaska (Unit 19) are examples of such a cautious strategy. On the other hand, lack of precision in assessments of fishery resources has unfortunately been used in other cases to argue that the evidence of overutilization was not strong enough to justify restricting a fishery. This argument has led to the depletion of many historically abundant stocks (e.g., most traditional New England groundfish and flounders in Unit 1).

Uncertainty about the relationship between marine mammals and fisheries now threatens both. For example, Steller sea lions (Unit 23) may rely on many of the same species of fish harvested in the Alaska trawl fishery. While the sea lion population has declined substantially, the scientific basis to determine if the fishery is negatively impacting these marine mammals is inadequate at present. A potential outcome of making management decisions without sufficient information could be that, in the case of Steller sea lions, a valuable fishery is unnecessarily restricted to protect the population or, alternatively, that the fishery unknowingly contributes to the further depletion of the sea lion population.

Considerable progress has been made over the last year in improving the management of U.S. living marine resources, though it may take several years before the benefits of these activities accrue to the Nation. In this section progress on various issues is briefly noted and summarized across the fishery units.

Management concerns for the overutilized resources in the Northeast have been addressed by the development of new management strategies for groundfish (Unit 1) and scallops (Unit 4) by the New England Fishery Management Council. The plans are not panaceas that will solve all the problems that affect these valuable fisheries, but they are an important beginning. Further work is well underway on lobster management also. For these resources, the proposal is to control access and facilitate rebuilding of the stocks by controlling fishing effort. In the short term, this will result in reduced catches by the commercial fleet, but as the stocks rebuild it is expected that catches and revenues will recover and exceed present levels. Management controls to rebuild the summer flounder stock enacted by the Mid-Atlantic Fishery Management Council in 1992 already appear to be paying off with signs of improved recruitment. Resource rebuilding programs are also underway for western Pacific bottomfish (Unit 17), Gulf and Atlantic coastal pelagics (Unit 7), reef fish (Unit 8), and drum and croakers (Unit 9). Access control has also been implemented for Pacific groundfish (Unit 15) and western Pacific pelagic species (Unit 18). Serious management concerns for the Atlantic shark resource (Unit 6) have begun to be addressed in a newly implemented FMP. Data collection will improve, and wasteful fishing practices are prohibited in the plan.

Access control through Individual Transferable Quota (ITQ) systems for surfclams and ocean quahogs in the Northeast (Unit 4) and wreckfish in the southeastern U.S. (Unit 8) have reduced the size of the fleets to rationalize the fishery and the shares appear to be holding their value. A similar system will soon be implemented in the Alaska region for Pacific halibut and sablefish. Controlled-access fisheries management, particularly ITQ's, remain controversial. It is up to the Councils to decide when these management tools are to be applied. Clearly the trend is in this direction.

New initiatives to mitigate the bycatch of nontarget and protected species have been undertaken in the Southeast with the development of an industry-NMFS cooperative research plan for bycatch. In the Northeast shrimp fishery (Unit 4) a device called the "Nordmore Grate" is being used by the industry to reduce finfish bycatch, with encouragement from the New England Fishery Management Council and NMFS. On the Pacific coast the Pacific Fishery Management Council has amended the groundfish FMP to authorize new management measures to reduce bycatch of salmon and other non-groundfish species (Unit 15). The North Pacific Fishery Management Council is actively managing salmon, halibut, and marine mammal bycatch problems through time and area closures to groundfish fishing and bycatch limits for individual vessels.

The continuation and expansion of at-sea observer programs around the country is also an important component needed to address the bycatch problem. In the Northeast, new analyses of observer data on bycatch of harbor porpoises (Unit 22) will be used in developing plans to reduce incidental capture and its impact on the porpoise population. In the North Pacific, the United Nations' sponsored moratorium on large-scale driftnet fishing, which went into effect at the beginning of 1993, has ameliorated the bycatch of mammals and sea turtles (Units 23 and 24).

Allocation problems between different sectors of a fishery are widespread and difficult to address equitably. In Alaska, community quotas have been instituted which reserve a portion of the total allowable catch for small scale fishermen from coastal communities (Unit 19). The Western Pacific Fishery Management Council has addressed allocation problems in their highly migratory pelagic species plan (Unit 18) by reserving nearshore areas for certain gear types and limiting the number of longline permits. Similar measures have reduced conflicts between fixed-gear and mobile-gear fishermen in

the Southeast (Unit 11).

Interjurisdictional issues have been addressed in recovery plans for summer flounder (Unit 1) and king mackerel (Unit 7), where state and Federal fishery scientists and managers have worked together to improve resource management. A major advance for the conservation of Atlantic salmon (Unit 3) was achieved by international agreement to close the salmon fishery off Newfoundland and to keep the quota low for the Greenland fishery. And now, even that small quota has been successfully purchased by private action to protect salmon. In the international waters of the central Bering Sea, cooperative multilateral research and negotiation has closed the walleye pollock fishery in this zone in 1993 and 1994 to allow rebuilding of this portion of the pollock resources.

New research on aquatic habitat needs for invertebrates in the Southeast (Unit 11), Hawaiian green turtles (Unit 24), and Atlantic marine mammals (Unit 22) is underway. These studies, along with other work which has improved our knowledge of the basic biology of marine resources, are an important component of scientific advice for management. The scientific basis for management has also improved through a large number of new assessments (e.g. American lobster, Unit 4; Atlantic sharks, Unit 6; Atlantic harbor porpoise, Unit 22; Hawaiian monk seal, Unit 23; Pacific mackerel and Pacific sardine, Unit 14; California sea lion and eastern Pacific spinner dolphin, Unit 23; and widow rockfish, Unit 15). This summary of progress during the last year is illustrative, not exhaustive. Improving the management of marine resources requires balancing a large number of competing concerns and interests and includes many difficult technical problems. Each year we are improving the scientific basis for management, strengthening management plans that maintain productive fisheries, and implementing new plans to recover overutilized fisheries and conserve protected resources.

Many of the issues and problems described in this national overview and in more detail in the individual fishery units to follow, have existed for many years in U.S. and indeed world fisheries. The many case studies in fisheries management both inside and outside the United States and the large body of scientific information now available, which makes a document such as "Our Living Oceans" possible, is pointing the way to solutions to many of our fishery management problems. The NOAA Strategic Plan (1993) has as goals, with respect to marine resources, to build sustainable fisheries for the long-term benefit of the Nation, recover protected species, and promote healthy ecosystems. The strategic plan advocates conversion of fisheries management from open access to controlled access (recognizing that it is the prerogative of the relevant Council to decide when such measures need be instituted); rapid expansion of scientific information; and risk-averse decisions on management actions. These three general strategies relate to each of the issues discussed above. Controlling fisheries access addresses the problems of management controls, overcapitalization, allocation, and jurisdiction. An increase in scientific information addresses the approximately 30% of stock groups whose status is unknown, and provides a stronger basis for the development of future management controls and recovery plans for protected species. In addition, improved scientific information will be essential for ensuring ecosystem health and addressing habitat concerns. Risk-adverse decision-making is a key element in the development of any improved management system. This means that managers should err on the side of caution with respect to long-term resource health when making decisions. Making decisions based on short-term goals often places long-term health at risk. The NOAA Strategic Plan and the NMFS are tasked with managing living marine resources for the sustained benefit of the Nation. We are moving in the right direction and there is great promise for increased benefits for the domestic fishing industry, recreational anglers, the general public, and future generations.

INTRODUCTION

The striped bass, *Morone saxatilis*, has played an important role in the life of U.S. Atlantic coast communities since the days of the colonists. In 1637 Thomas Morton wrote "The basse is an excellent Fish," which "for daintiness of diet, excell the Marybones of Beefe... I ... have seene such multitudes passe out of a pound, that it seemed to mee, that one might goe over their backs drishod."[1] In 1670, the first public school in the New World was funded in part through taxes on sales of striped bass.[2] In succeeding centuries, striped bass stocks would undergo dramatic fluctuations in abundance; however, the importance of striped bass to coastal communities has never diminished.

Also called rockfish or rock, the striped bass is anadromous, spawning in brackish to freshwater reaches of estuaries. Once distributed from Canada to northern Florida, Atlantic coast spawning stocks are now reduced to three major areas: Hudson River, Chesapeake Bay, and the Roanoke River. Most juvenile striped bass live in estuarine waters for the first several years of life, and then they migrate to coastal waters of southern New England and the Gulf of Maine to feed. In spring, the mature bass return to brackish or freshwater reaches to spawn. The Chesapeake and Hudson stocks produce most of the fish which sustain east coast fisheries; Roanoke fish appear to be less migratory than the more northern stocks. Striped bass can reach a size of 75 pounds or more and probably live at least 30 years.

As early as the mid-1700's, concern over depletion of striped bass stocks began to surface. Several reports of that era document scarcities caused by "very great numbers having been imprudently, or rather *wantonly* taken in one season."[3] More recently, similar concerns have been raised, particularly over the status of the Chesapeake Bay stock. During the late 1960's and early 1970's, Chesapeake Bay produced the majority of striped bass found in coastal waters. Strong year

DEFINITION OF TERMS

Fishery-dependent monitoring: Sampling a population by examining the catch in fisheries. For example, age composition of the exploited portion of a population may be estimated by collecting scale samples from fish in landings. Fishery-dependent samples tend to be somewhat biased due to the selective nature of fisheries.

Fishery-independent monitoring: Sampling a population using scientific methods, with the goal of obtaining unbiased estimates of population characteristics.

Recruitment: The amount of fish added to a population through successful reproduction each year.

Recruitment index: A measure of the abundance of the new fish added to the population in a given year. For striped bass, the index is generally the average catch of juvenile striped bass per beach-seine haul at a number of sampling locations over a 2-3 month period.

Annual fishing mortality: The percentage of a fish population that dies due to fishing during a year.

Annual total mortality: The percentage of a fish population that dies due to all causes (fishing, disease, predation, etc.) during a year.

Striped bass. (ASMFC photo.)

. . . INTRODUCTION

classes had been produced about every 2-4 years, with an exceptionally large one appearing in 1970. Commercial landings were rising steadily and reached a peak of 6,700 metric tons (t) in 1973. Then the picture began to change. Year after year, strong year classes failed to appear. Landings began a sharp decline and by 1983 had slipped below 1,000 t (Fig. 1). This situation alarmed fishermen, biologists, and managers alike, and prompted unprecedented research and conservation efforts.

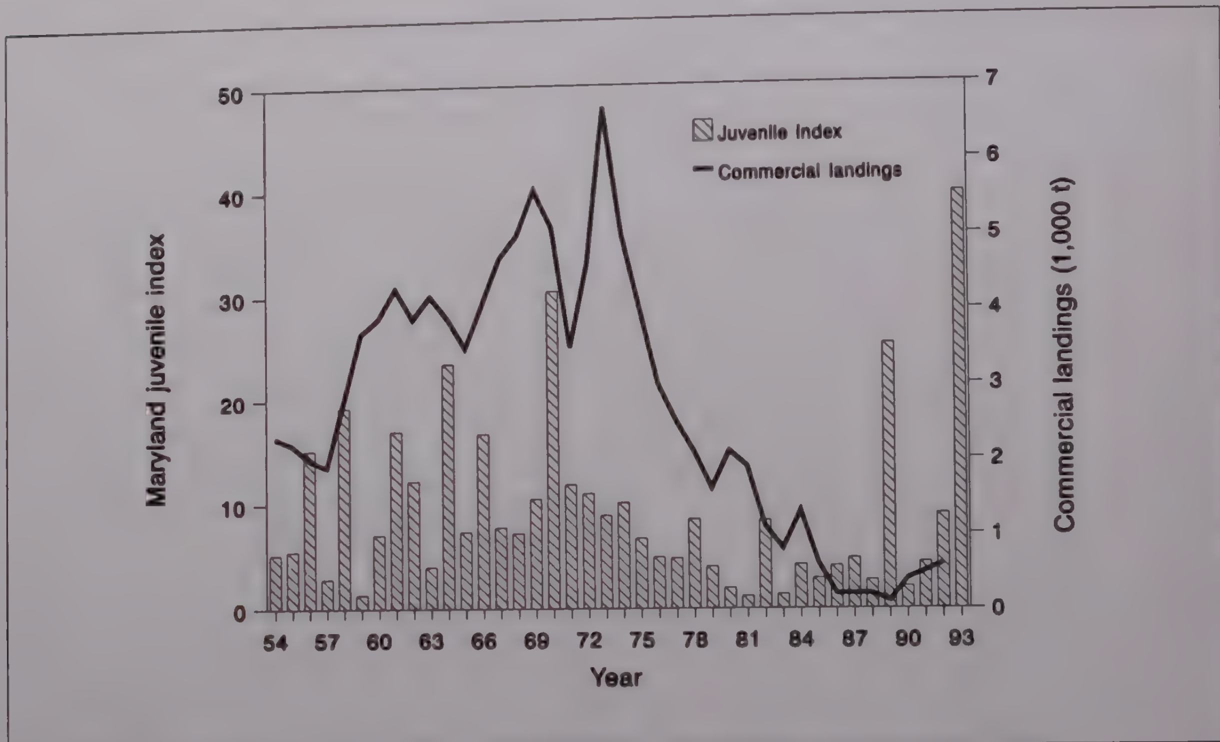
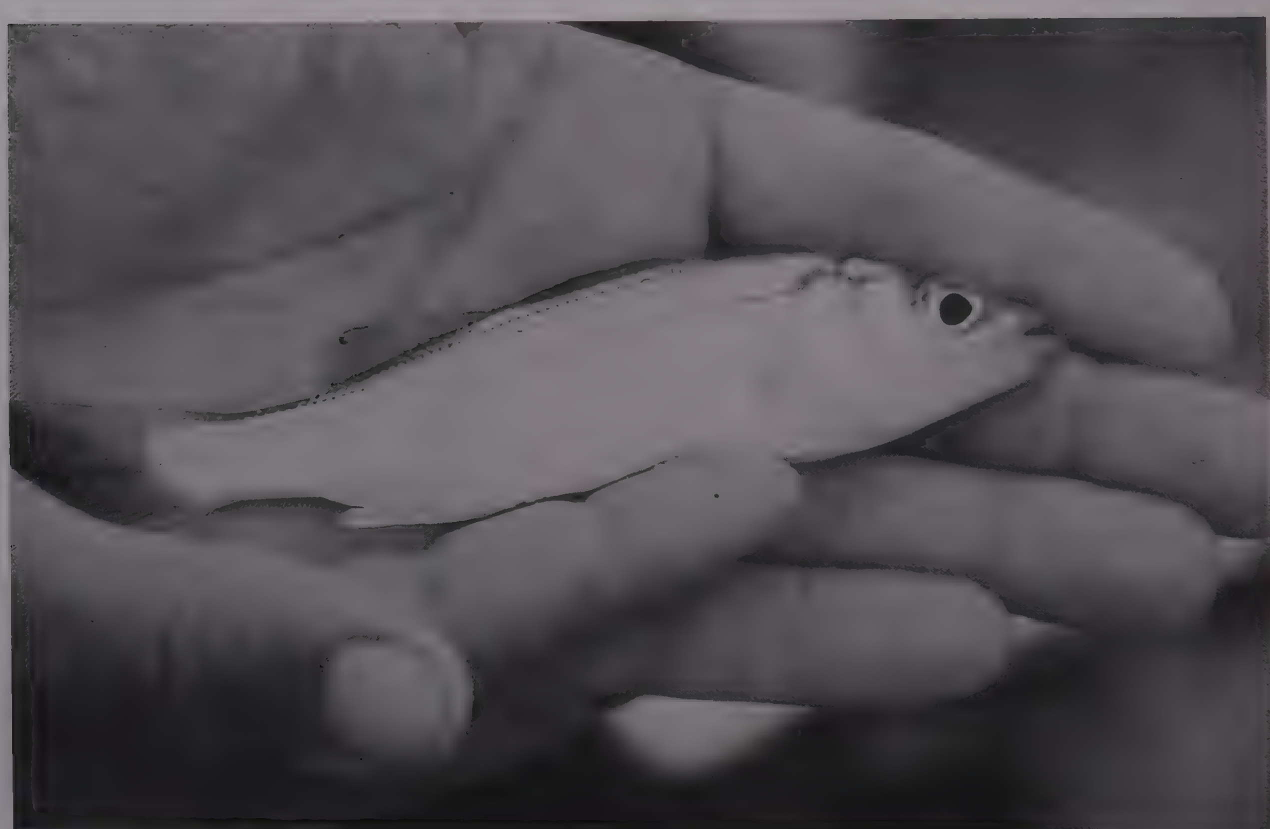


Figure 1.–Indices of juvenile Atlantic striped bass recruitment for Maryland's waters of Chesapeake Bay and commercial landings from 1954 to 1992. The juvenile index is the average number of striped bass caught per seine haul at 22 sampling locations in Maryland waters.



A juvenile striped bass sampled in the Maryland juvenile index survey. ASMFC photo.

STRIPED BASS MANAGEMENT

Prior to 1981, no comprehensive management plan existed for Atlantic striped bass; however, many of the states from North Carolina to Maine had started issuing their own regulations by the 1940's. These typically included minimum size limits of 10-12 inches in states south of New Jersey and around 16 inches in the northerly states. While the regulations may have provided some measure of protection, they were clearly inadequate to preserve spawning stocks in the face of escalating fishing pressure. To complicate matters, the migratory habits of striped bass meant that if only some states raised their size limits, fish protected by one state would likely be harvested by others. A cooperative approach to management was needed. This prompted the Atlantic States Marine Fisheries Commission (ASMFC) to begin development in 1979 of an interstate striped bass management plan.

The ASMFC, a compact of 15 Atlantic coast states and jurisdictions, was formed in 1942 to promote conservation of shared fishery resources. Although it had no regulatory authority, the ASMFC provided a forum for developing management recommendations which coordinate conservation efforts among its member jurisdictions. In 1981, the ASMFC adopted its "Interstate Fisheries Management Plan for the Striped Bass" which called for minimum size limits of 14 inches total length (TL) in bays and estuaries and 24 inches TL along the coast. In addition, the plan recommended that major spawning areas be closed to fishing during the spawning season. The plan's recommendations were gradually adopted by most states; however, striped bass recruitment remained near record low levels.

Recognizing that more stringent measures were necessary, ASMFC amended the plan three times during 1984 and 1985 to further restrict fishing. The first two amendments set general targets for reducing fishing mortality rates and allowed flexibility in the methods for achieving reductions. The third and most stringent amendment focused on protecting the 1982 year class, which, though only average, was the best since the plan had been implemented. Specifically, the amendment recommended that the states protect 95% of the females of the 1982 and subsequent year classes until 95% had an opportunity to spawn. This meant each state must either institute a complete moratorium on fishing or increase minimum size limits to stay ahead of the females' growth. Most states chose to increase size limits. Since 95% maturity of Chesapeake Bay striped bass probably does not occur until age 8, size limits would have to reach 38 inches TL as 1990 approached. The sliding size limits were tantamount to a closure, since there were virtually no fish remaining from earlier year classes which might exceed the size limits.

ASMFC's adoption of the third amendment to the plan, with its drastic measures, was a major milestone in the attempt to restore Chesapeake Bay striped bass. Equally important, however, was passage by the U.S. Congress of the Atlantic Striped Bass Conservation Act (Conservation Act) in 1984. This law significantly strengthened the ASMFC's position by providing an indirect mechanism, beyond consultation and prescription, that stipulated that if any state did not comply with the plan, that state would be subject to a Federal moratorium on striped bass fishing in its waters. Because ASMFC does not have explicit regulatory powers over striped bass, its plans are only recommendations to the states; prior to the Conservation Act the states could simply ignore the recommendations if they chose. It seems likely that few states would have fully complied with the third amendment, given the political and economic unpalatability of its measures. Indeed, Federal moratoria had to be threatened in several instances and implemented once before regulations were brought into compliance with the plan. Further, the Conservation Act ensured equality — that all states would share equally in the hardship imposed by the plan.

An additional act of Congress prompted by the striped bass decline was to play an important role in supporting striped bass management. In 1979, the Anadromous Fish Conservation Act was amended to provide for an "Emergency Striped Bass Study." This study, now the "Striped Bass Study" (SBS), was to monitor the status of the striped bass stocks and determine the reason(s) for the decline of the coastal

Striped bass. USFWS photo.

. . . STRIPED BASS MANAGEMENT

population. Because striped bass occur primarily in coastal waters, fishery-independent monitoring is conducted by the states. During the 1970's, monitoring efforts were so sporadic that it was not even possible to demonstrate definitively that the decline in landings was due to a decline in the stock. Fishing mortality rates were not available and the status of the spawning stock was not clear. In addition, the reasons for the decline were poorly understood. The SBS provided funding and a Federal administrative framework for developing a coordinated research program involving states, universities, and private corporations.

The two Acts of Congress forged a unique partnership between the states and the Federal government. While the states have primary responsibility for management through the ASMFC, the Federal government plays a strong role through the Conservation Act and the SBS. Federal responsibility in both areas is shared equally between NOAA's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). The NMFS has primary responsibility for overseeing monitoring programs through the SBS, and the USFWS has the lead on investigating causes for the decline. Both agencies are jointly involved in all decisions emanating from the Conservation Act, including the imposition of any Federal moratorium. In addition, the Federal agencies participate in the ASMFC management process by providing voting members to the striped bass scientific committees and the management board.

CAUSES OF THE DECLINE

When the SBS was organized, a number of hypotheses were formulated which could explain the decline of the Chesapeake stock. These included the effects of ecological interactions such as competition, predation, and starvation; environmental problems including eutrophication, toxic contaminants, degradation of water quality, and changes in water use practices; the occurrence of unfavorable natural climatic events; disease; and overfishing. Not all hypotheses could be evaluated equally well. For instance, with striped bass populations at extremely low levels, it was difficult to address hypotheses dealing with ecological interactions. Further obstacles to reaching a definitive conclusion included the retrospective nature of the problem and the likelihood that several interacting factors were involved.

Despite the difficulties, significant

CAUSES OF THE DECLINE

progress has been made in clarifying probable causes of the decline of the Chesapeake stock. It is highly likely that excessive fishing pressure decimated the spawning stock and set the stage for the decline. Reproductive success of the remaining spawners may have been compromised by water quality problems which reduced survival in the early life stages. Additional factors may have also contributed, but their role is less clear.

The evidence implicating overexploitation is piecemeal but compelling. Fishing mortality estimates from the 1970's are insufficiently frequent to reveal trends; however, the intermittent estimates that exist are extremely high. Along the coast, annual fishing mortality estimates range from 24% to 59% per year. Estimates from Chesapeake Bay indicate total annual mortality rates of 45% on 1970 year-class females at age 6 and 93% on males at age 5. Models predicting mortality rates needed to explain observed catches during the 1970's similarly suggest excessive fishing mortality. Recreational fishing effort increased steadily throughout the 1960's and 1970's. In the absence of significant conservation measures, striped bass fishing mortality undoubtedly followed a parallel trend.

The evidence suggesting that water quality problems may have contributed to the decline is based primarily on in situ bioassays conducted during the 1980's. Historical data on pH in major spawning rivers have been examined, but no evidence of a general decrease in pH or of increased frequency of low pH events has been found. However, the data would have been adequate only for detecting major changes, not changes on small spatial or temporal scales. The importance of small-scale effects was clearly demonstrated during larval bioassay tests conducted in 1988. A low-pH rainfall occurred which decreased the pH in a nursery area of the Nanticoke River from 7.2 to the low 6's in an 8-hour period. Within 24 hours, the pH had returned to normal. Mortality of larvae held in the river water was 100% during the 24-hour period of the pH excursion, whereas mortality of controls held in well water was only 10%. This and several years of in situ bioassays, water quality monitoring, and laboratory experimentation suggest that conditions that could periodically cause catastrophic mortality do occur in some (but not all) spawning and nursery areas of Chesapeake Bay. Whether the frequency of such events increased during the 1970's or was severe enough to cause a decline remains unknown.

Excessive fishing and episodic poor water quality could have had synergistic effects far more disastrous than either alone. Fishing reduced the number of striped bass and truncated the age composition of the spawning stock. This may have reduced the duration of the spawning season as well as the number of eggs produced, since older fish appear to spawn earlier than younger fish. With spawning concentrated in a shorter time period, a catastrophic mortality event potentially could kill a larger proportion of a given year's spawn. An additional effect of the truncated age structure may have been to reduce viability of the spawn. Younger females not only produce fewer eggs than older ones, but their eggs are less viable as well.

POPULATION MONITORING

Establishment of the SBS provided a unique opportunity to develop or expand monitoring programs at a time when a major management experiment was about to begin. Prior to the 1980's, fishery-independent monitoring for striped bass was limited to juvenile surveys conducted in New York, Maryland, and North Carolina waters. Virginia had begun a juvenile survey in 1967 but abandoned it after 1973. Occasional sampling to characterize the spawning stock had been conducted in all three stock areas; however, consistent, continuing programs for spawning stocks and the coastal migratory population had never been developed. In addition, sampling of commercial landings was inadequate for biological characterization of the catch.

NMFS funding through the SBS was used to begin a juvenile survey in the Delaware River, to reestablish the juvenile survey in Virginia's waters, and to augment the existing survey in the Hudson River. Spawning stock sampling programs were initiated in the Chesapeake Bay and in the

. . . POPULATION MONITORING

Hudson River. A program for monitoring the coastal stock during its fall migration was started. In addition to the sampling programs, a coastwide tagging study was established which involved most of the states from North Carolina through Maine. During the early 1980's, while commercial fisheries were still active, fishery-dependent monitoring was expanded in many of the states.

In addition to monitoring, the SBS funded research to reevaluate population characteristics such as maturation and migration rates. These were used directly in management and were critical to the development of models to predict the response of the population. For example, Amendment 3 to the ASMFC's plan depended on estimates of maturation rates to develop the schedule of increasing size limits. At the time the amendment was written, the least biased maturation schedule available for Chesapeake Bay striped bass was developed during the 1930's and was based on only 109 females spread across six age classes.

POPULATION RESPONSE

When spawning stock monitoring began in Maryland during the early 1980's, females were virtually absent on the spawning grounds. Most were 10 years old or older, rare survivors from the strong 1966 and 1970 year classes (Fig. 1). As the 1980's progressed and the 1982 year class began to mature, the protection afforded by the ASMFC plan began to be reflected in the spawning stock. Females of the 1982 year class began to make a significant contribution to the spawning stock as early as 1986, when they first began to mature. By 1988, the 1982 and subsequent year classes were responsible for the bulk of the egg production. Older, more fecund females were very rare and contributed relatively little to the population fecundity after 1988.

The results of the conservation efforts soon became apparent in other areas as well. Sampling of the migratory population showed that the bulk of the mixed stock was composed of members of the protected year classes. The Hudson stock, although never depressed, also benefitted from the regulations designed to protect Chesapeake fish in coastal waters. Recruitment in the Hudson reached record high levels, and the abundance of the spawning stock increased. Juvenile indices in Virginia rose to their highest recorded levels during the late 1980's. The recreational catch increased, and over 90% were released alive as minimum size limits continued to increase (Fig. 2). More recently, there is evidence for a partially restored spawning stock returning to the Delaware River.

Despite the effectiveness of the ASMFC plan in rebuilding the stock, recruitment in Maryland's waters of the Bay remained at or near the lowest recorded levels throughout most of the 1980's. Then in 1989, the catch of juveniles was extremely

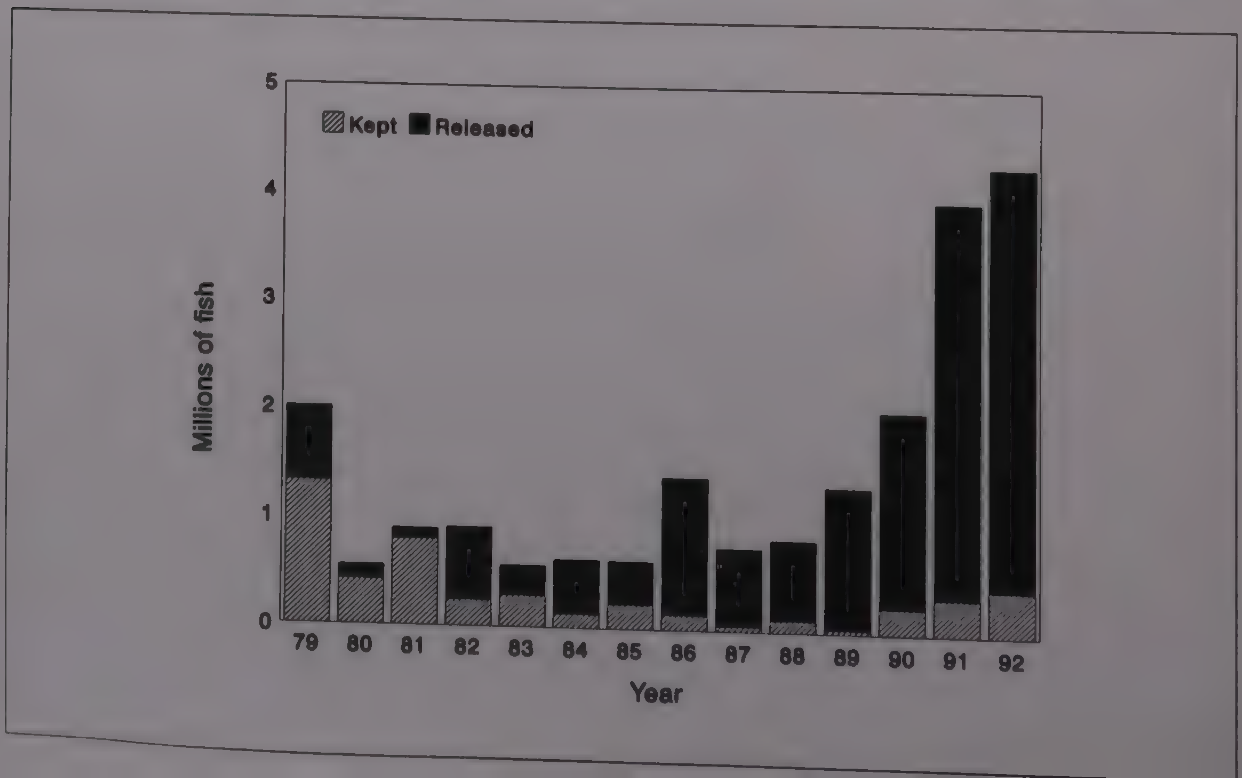


Figure 2.–Recreational catch (millions of fish) of striped bass along the Atlantic coast from North Carolina through Maine, 1979-92. Solid bars are fish that were released; cross-hatched bars represent fish that were kept.

. . . POPULATION RESPONSE

high in portions of Maryland's Choptank River, producing a recruitment index which was second only to the index for the dominant 1970 year class. Recruitment in other Maryland nursery areas was not exceptional that year, but it was high in Virginia's waters of the Bay.

The significance of Maryland's 1989 juvenile index went beyond its potential implications for recovery of the Chesapeake stock. Amendment 3 of ASMFC's plan stipulated that the stringent regulations protecting the 1982 and subsequent year classes would remain in place until the 3-year average of the Maryland juvenile index exceeded 8.0, the approximate long-term average. Although the 1987 and 1988 juvenile indices were low, the 1989 index was sufficiently large to bring the 3-year average over 8.0 and to initiate a new management regime.

CURRENT MANAGEMENT

Amendment 4 to the ASMFC's plan, adopted in October 1989, represents a new, adaptive approach to conservation of Atlantic striped bass. Its basic premise is that the populations must be managed first to restore and maintain the spawning stocks and secondarily for fishery yield. The management objectives are to be achieved by monitoring fishing mortality rates and adjusting regulations should the rates differ from target levels. Two levels of fishing mortality are identified. The first level is projected to allow the stock to continue to increase, although at a slower pace than under no exploitation at all. The second level is a maintenance level appropriate to a fully recovered stock. The decision to move from the restoration level to the maintenance level is to be based on several indicators of stock status, including recruitment indices and condition of the spawning stock.

Under Amendment 4, the states have been allowed to relax regulations and prosecute tightly controlled fisheries since 1990. Along the coast, minimum size limits for the recreational fishery now range from 28 to 36 inches. Minimum size limits are lower (e.g. 18 inches) in estuarine waters because larger striped bass are not available except during the spawning season. In addition to size limits, daily bag limits of 1-2 fish are imposed, and some states enforce seasonal closures as well. One state (Maryland) employs a quota system to control its harvest.

The commercial fishery is much reduced compared to historical levels. Several jurisdictions have made striped bass a sport-catch-only species, and those which retain commercial fisheries impose strict seasonal restrictions in addition to minimum size limits. Commercial fisheries are further limited by harvest caps equal to 20% of each state's landings during 1972-79. Although not required by the plan, many states close their commercial fisheries if landings exceed the cap before the end of the open season.

Adaptive management and the use of caps on commercial landings require intensive monitoring of stocks and fisheries. As part of Amendment 4, each state has certain monitoring requirements which it must carry out to be in compliance with the plan. For example, states with significant recreational fisheries must estimate their recreational catch with a coefficient of variation (a statistical measure of uncertainty) not to exceed 20%. States with spawning habitat must conduct spawning stock assessments and juvenile surveys. Most states are required to participate in fishery-independent monitoring and/or tagging studies used to estimate mortality rates.

Three years of fishing under Amendment 4 were completed as of the end of 1992. Fishing mortality estimates during these three years have approximated the target rates. Some liberalization of regulations has occurred since fisheries reopened in 1990; however, most states have voluntarily kept their regulations more stringent than allowed by the amendment. Indices of adult stock status show continued broadening of the age structure and increased abundance in many areas. Recruitment in Maryland's waters was poor in 1990 and 1991; however, in 1992 recruitment rose to average levels and in 1993 exceeded all previous record highs. The 1993 index was particularly encouraging because juveniles were abundant in many areas of the Chesapeake Bay. Recruitment was similarly high in other spawning stock areas during 1993.

CONCLUSIONS

The Atlantic coast striped bass fisheries of the 1970's and 1980's can be viewed as a large-scale experiment in fisheries management, the results of which are still being evaluated. Several lessons have been learned and more undoubtedly remain to be uncovered.

Perhaps the key to setting the stage for recovery of the Chesapeake striped bass stock was the Atlantic Striped Bass Conservation Act, which lent authority to the ASMFC's plan. Without the clout provided by the Conservation Act and its assurance of equality among the states, political and economic impediments undoubtedly would have prevented the states from undertaking the dramatic measures recommended in the plan.

Historical precedence is often invoked as a reason to continue unwise fishery management practices. The striped bass experience demonstrates that it is possible to break with long-established patterns. Unfortunately, the striped bass stock had to be driven virtually to economic extinction before significant changes were made. As Jeremy Belknap wrote in 1792 regarding depletion of striped bass in the Piscataqua River, "After the mischief was *done*, a law was made against it..."[4] ASMFC and the states have wisely embarked on a new management regime as the stocks recover, rather than returning to former ways. Hopefully, they will resist the temptation to allow overharvesting as the stock becomes fully restored and will prevent the mischief of the 1970's from recurring.

At present, much is being learned about applying the concept of adaptive management to Atlantic striped bass. In practice, a major commitment of time and money as well as extensive cooperation among the states is needed. A potential roadblock in the striped bass process is the mismatch between monitoring required by the plan and the ability of the states to supply the funds and manpower to conduct it. Without extensive monitoring, information will be inadequate to guide management changes, yet no dedicated funds exist for conducting this research. Along similar lines, the issue of deciding whether management targets are met is not a trivial one. Uncertainty in parameter estimates can be used in the political arena to justify avoiding action when a management change would be the conservative response.

The positive response of Atlantic striped bass populations to the management initiatives of the 1980's provides a dramatic demonstration of the impact that effective fishery management can have, and furnishes an encouraging example for other seriously overexploited fisheries. Building on this experience, Congress passed new legislation in late 1993 extending the striped bass management paradigm to other Atlantic coastal species.

The increase in the spawning stock and improved recruitment in 1992 and 1993 are cause for optimism that the Chesapeake population is truly on the road to recovery. However, it would be premature at this point to consider the cure complete. To the extent that water quality problems compromise early life-stage survival, strong year classes may occur infrequently despite the improved status of the spawning stock. To ensure the best chances for a complete, sustained recovery, diligent conservation efforts must continue into the future.

FOOTNOTES

[1]Thomas Morton. 1637. New English Canaan, or New Canaan, Containing an Abstract of New England. Amsterdam. Cited in Fearing, D.B. 1903. Some early notes on striped bass. Trans. Am. Fish. Soc. 33:90-98.

[2]Pearson, J.C. 1938. The life history of the striped bass, or rockfish, *Roccus saxatilis* (Walbaum). Fish. Bull. 49:825-860.

[3]Samuel Tenney, in "Topographical Description of Exeter in New Hampshire, in Massachusetts." Historical Society Collections, 1st Series (Boston, 1795) IV.

[4]Jeremy Belknap in "History of New Hampshire," Boston, 1792.

Part 2: UNIT SYNOPSES

INTRODUCTION

Northeast demersal (groundfish) fisheries include about 35 species and/or stocks, primarily in New England waters, but also off the Mid-Atlantic states. In New England, the groundfish complex is dominated by members of the cod family (cod, haddock, hakes, pollock), flounders, dogfish sharks, and skates. Mid-Atlantic groundfish fisheries land primarily summer flounder, scup, goosefish, and black sea bass.

Northeast groundfish fishermen utilize such fishing gears as otter trawls, gill nets, traps, and set lines. Otter trawling is the predominant fishing method for groundfish throughout the region (there were 1,056 otter trawl vessels in the fleet in 1992); gill nets contribute a substantial proportion of the landings in the Gulf of Maine (258 vessels fished gill nets in 1992). Many of the vessels participating in the groundfish fisheries switch gears on a seasonal basis. Recent average U.S. landings of mixed groundfish in the northeast region were 170,000 t. If Canadian and recreational landings of these stocks are included, 1992 groundfish landings were still less than half of their estimated long-term potential (Table 1-1).

Groundfish resources off the northeast occur in mixed-species aggregations, resulting in significant bycatch interactions among fisheries directed to particular target species or species groups. Management is very complex because of these

Table 1-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	508,621 t	(378,806 t, U.S. only)
Current potential yield (CPY) =	414,221 t	(308,500 t)
Recent average yield (RAY)[1] =	227,721 t	(169,600 t)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Groundfish/flounders					
Atlantic cod[2, 3]	54,400	60,000	45,000	Over	Below
Pollock[2, 3, 4]	46,300	40,000	37,000	Full	Near
Silver hake	17,500	20,000	100,000[6]	Full	Below
Summer flounder[3]	9,000	6,000	20,000[6]	Over	Below
Winter flounder[3]	7,700	9,000	16,000[6]	Over	Below
Yellowtail flounder	9,100	6,000	39,000	Over	Below
Haddock[2, 5]	6,500	6,000	52,000	Over	Below
American plaice	4,500	2,400	10,000[6]	Over	Below
Witch flounder	1,800	1,500	3,500[6]	Over	Below
Windowpane	2,000	2,000	5,000[6]	Full	Near
Red hake	1,200	Unknown	40,000[6]	Under	Near
Redfish	600	600	14,000	Over	Below
Skates/dogfish					
Skates	11,600	25,000	25,000	Under	Above
Spiny dogfish	12,300	200,000	50,000	Under	Above
Other finfish					
Goosefish	14,200	10,000	10,000[6]	Over	Below
Scup[3]	8,000	6,700	12,500[6]	Over	Below
White hake[2]	7,100	5,000	5,000[6]	Full	Near
Weakfish[3]	5,000	Unknown	Unknown	Unknown	Unknown
Black sea bass[3]	2,500	Unknown	Unknown	Full	Below
Cusk[2]	2,100	1,200	1,500[6]	Over	Below
Ocean pout	1,100	1,300	12,500[6]	Full	Near
Spot[3]	1,500	Unknown	Unknown	Unknown	Unknown
Tilefish	1,200	900	Unknown	Over	Below
Wolffish	500	400	700[6]	Over	Below
Atlantic halibut	21	Unknown	Unknown	Over	Below

[1]1990-92 average.
[2]Includes more than 100 t of foreign landings (primarily Canadian).
[3]Includes more than 100 t of recreational landings.
[4]For pollock, U.S. landings are only 8,300 t (18%) of the RAY.
[5]For haddock, U.S. landings are only 2,200 (34%) of the RAY.
[6]Provisional LTPY's, based on historical landings patterns.

. . . INTRODUCTION

interactions. This complexity is reflected, for example, in the use of differing mesh, gear, minimum landing sizes, and seasonal closure regulations, set by such groups as the New England and Mid-Atlantic FMC's, the states, ASMFC, and by the Canadian Government, because of the transboundary nature of some stocks. New England groundfish are managed primarily under the Northeast Multispecies FMP (13 species), as well as peripherally under provisions of the ASMFC Northern Shrimp Management Plan. Mid-Atlantic groundfish are managed under the Summer Flounder FMP. Management of the demersal fisheries in New England is by indirect methods including mesh sizes, minimum fish lengths, and some area closures. There are currently no direct controls on New England groundfish fishing mortality rates through catch quotas or effort regulations. The Summer Flounder FMP includes provisions for catch quota targets aimed at restoring this depleted stock.

Extensive historical data for the northeast demersal fisheries have been derived from both fishery-dependent (i.e. catch and effort monitoring) and fishery-independent (NOAA research vessel) sampling programs. Since 1989, a sea sampling program has been conducted in the region aboard commercial vessels, in order to document discard rates and to collect high quality, high resolution data on catch by area and effort by gear set. Some of the northeast demersal stocks (cod, yellowtail flounder, haddock, American plaice, pollock) are among the best understood and assessed fishery resources in the country.

SPECIES AND STATUS

Principal Groundfish and Flounders

The principal groundfish and flounders group includes important cod-family species (Atlantic cod, haddock, silver and red hake, pollock), flounders (yellowtail, summer, winter, witch, windowpane, and American plaice) and redfish (Fig. 1-1). Recent annual landings of these 12 species (19 stocks) by commercial fishermen have averaged 161,000 t, as compared with LTPY's of nearly 400,000 t (Table 1-1). Total ex-vessel revenue from principal groundfish and flounder commercial landings in 1992 was $161 million. The northeast groundfish complex supports important recreational fisheries for species including summer flounder, winter flounder, and Atlantic cod.

The abundance index for this group declined by almost 70% between 1963 and 1974, reflecting substantial increases in exploitation associated with the advent of distant-water fleets (Fig. 1-1). Many stocks in this group declined sharply, notably Georges Bank haddock, most silver and red hake stocks, and most flatfish stocks. By 1974, indices of abundance for many

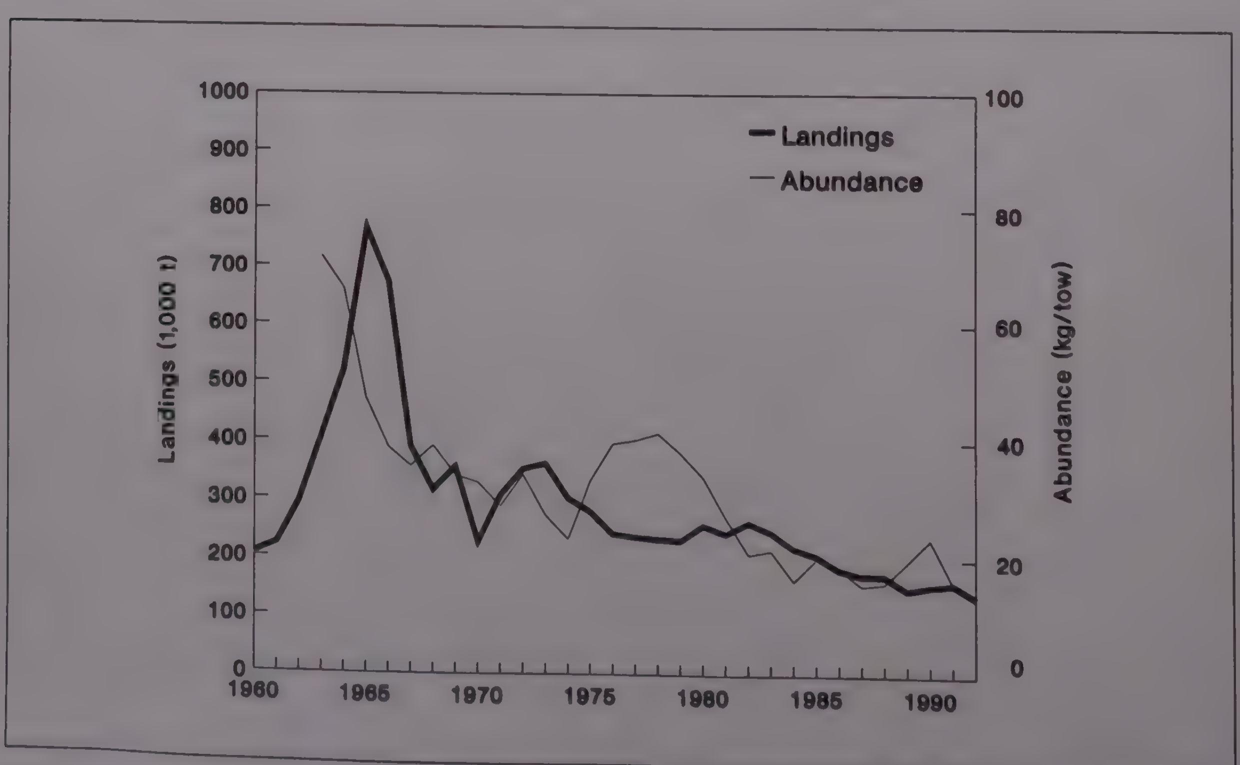


Figure 1-1.—Total commercial landings and abundance indices for principal groundfish and flounders off the New England coast, 1960-92. Abundance indices are mean weight (kg) per tow taken in Northeast Fisheries Science Center (NEFSC) autumn bottom trawl surveys. Species include: Atlantic cod, haddock, pollock, redfish, the silver, red, and white hakes, American plaice, and the yellowtail, winter, windowpane, witch, and summer flounders.

. . . Principal Groundfish and Flounders

of these species had dropped to the lowest ever recorded.

Groundfish partially recovered during the mid-to-late 1970's because of reduced fishing effort associated with increasingly restrictive management under the International Commission for the Northwest Atlantic Fisheries (ICNAF) during the early 1970's, and implementation of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1977. Cod and haddock abundance increased markedly; stock biomass of pollock increased more-or-less continually, and recruitment and abundance also increased for several flatfish stocks. The aggregate index peaked in 1978. Subsequently, the combined index again declined, reaching new lows in 1987 and 1988. The 1989 and 1990 abundance values were slightly higher than the previous two years, primarily due to recruitment of moderate 1987 year classes of Atlantic cod and yellowtail flounder. However, the abundance indices in 1991 and 1992 again declined due in large part to the rapid depletion of the 1987 yellowtail flounder year class and declining cod abundance. The 1992 index of groundfish abundance was a time series (30-year) low. Landings of these species in 1993 are predicted to decline substantially, in the face of generally poor recruitment. Landings of cod, haddock, and yellowtail flounder are currently at the lowest level since the 1950's, when demand for fish and total fishing effort were low. Fishing effort directed to the groundfish complex increased from 1991 levels despite substantial declines in CPUE.

Gadus morhua

Skates and Dogfish Sharks

Dogfish and skates are a significant and growing part of the aggregate groundfish stock biomass in the Northeast (Fig. 1-2). Of the two dogfishes (spiny and smooth), the spiny dogfish is dominant by far. Seven species of skates, including little, winter, barndoor, brier, thorny, leopard, and smooth-tailed occur on the northeast shelf. Winter, little, and thorny skates produce most of the landings.

Skate and spiny dogfish landings have generally increased in recent years. Total landings of small elasmobranchs in 1992 were about 25,000 t, up slightly from 1991. These landings levels are well below the long-term potential landings for these stocks and their current potential yields. The stocks of skates and dogfish increased

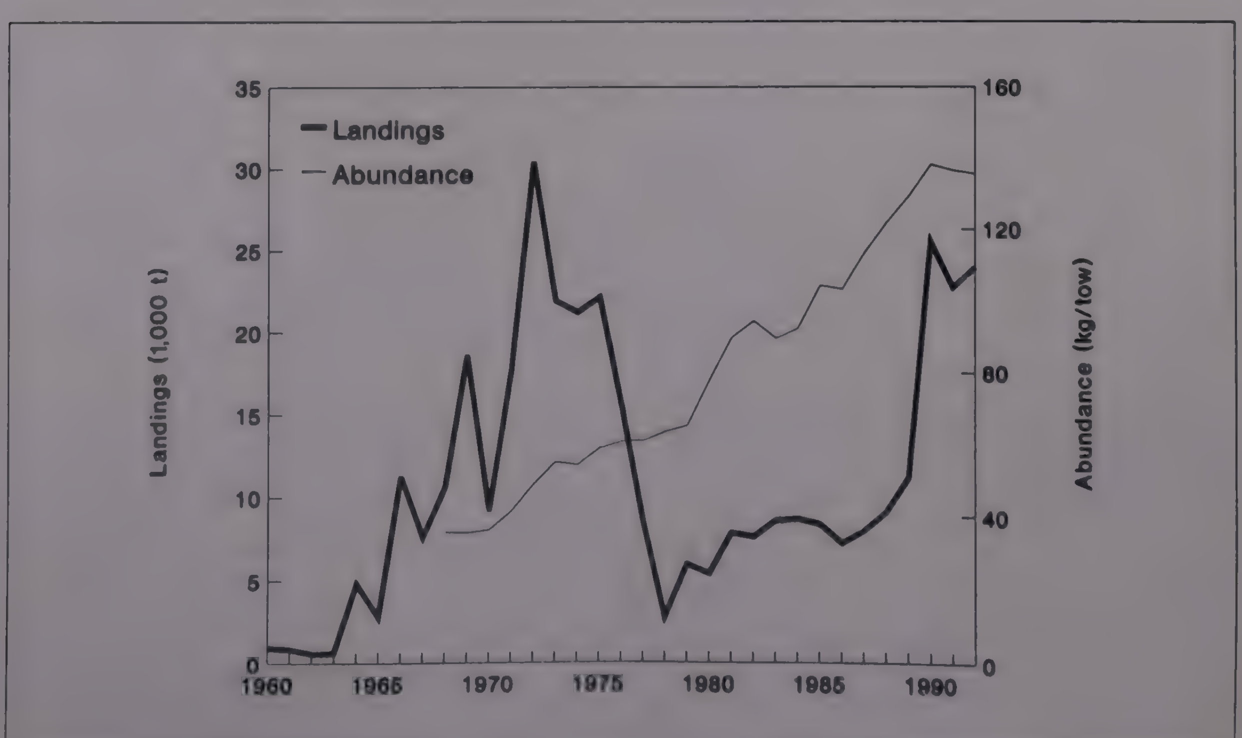


Figure 1-2.—U.S. commercial landings and abundance indices for skates and dogfish off the northeastern U.S. coast, 1960-92. Abundance indices are mean weight (kg) per tow taken in NEFSC spring bottom trawl surveys. Species include little, winter, barndoor, brier, thorny, leopard, and smooth-tailed skates, and spiny dogfish.

. . . Skates and Dogfish Sharks

throughout the 1970's and 1980's (Fig. 1-2). Survey catches of both dogfish and skates since 1986 have been the highest observed in the time series. Increases in dogfish and skate abundance, in conjunction with declining abundance of groundfish and flounders, have resulted in the proportion of dogfish and skates in Georges Bank survey indices increasing from roughly 25% by weight in 1963 to nearly 75% in recent years.

Other Finfish

Other groundfish species taken primarily as bycatch in the Gulf of Maine include goosefish, white hake, cusk, wolffish, and Atlantic halibut. In Southern New England, goosefish and ocean pout are important groundfish stocks, and in the Middle Atlantic, scup, weakfish, black sea bass, spot, tilefish, and several others are landed either in directed fisheries or as bycatch. As a group, they are generally characterized as over-exploited, with current landings generally well below long-term maxima (Table 1-1). Most of these stocks are managed implicitly with other species included in various FMP's. For example, white hake, goosefish, cusk, wolffish, and halibut are taken in various groundfish fisheries regulated under the Northeast Multispecies FMP. Similarly, scup and black sea bass represent major components of the summer flounder directed fishery, and these stocks are likely to be included in future amendments to the Summer Flounder FMP. ASMFC has developed an FMP for weakfish, and several other stocks are slated for inclusion in future FMP's. The advent of directed fishing for goosefish at the edge of the continental shelf in the Middle Atlantic and Southern New England areas has prompted interest in developing regulations for the fishery, primarily because very small animals are currently landed from that fishery and as bycatch from sea scallop dredge fishing.

ISSUES

Management Concerns

New England groundfish resources are currently regulated by indirect controls on fishing mortality, including mesh and minimum fish size restrictions and some area closures. In the face of persistent overfishing of the resource, the Conservation Law Foundation (CLF) and the Massachusetts Audubon Society filed litigation aimed at removing the overfished conditions. A consent decree was entered into between NMFS and CLF, stipulating that measures be developed that would eliminate the overfished condition of cod and yellowtail in 5 years and haddock in 10 years. The current version of Amendment #5 to the New England Multispecies FMP calls for an effort reduction program to be initiated in 1994 to address these requirements. The regulatory package includes a moratorium on new vessel entrants, a schedule of reductions in days-at-sea for trawl and gill net vessels, increases in regulated mesh size, and expanded closure areas to protect haddock. The objective of the plan is to gradually eliminate the overfished condition of cod, yellowtail flounder, and haddock over 5-7 years. In contrast, the Summer Flounder Plan has instituted a strategy to cut fishing mortality in 1993 by 50% from 1992 levels, and eventually to achieve F_{max}, the longer-term management target levels. The Summer Flounder FMP uses catch quotas, allocated by state and season, to achieve the management goals. Recent increased recruitment levels, combined with lower fishing mortality rates in 1993, will reverse the trend of declining biomass, and result in stabilized or increasing landings in the next few years.

Transboundary Stocks and Jurisdiction

Significant catches are taken from transboundary stocks of Atlantic cod, haddock, and pollock from Canadian waters. In 1992, 41% of Georges Bank cod, 67% of Georges Bank haddock, and 78% of Northwest Atlantic pollock landings were taken by Canada. Management regulations employed by the two countries are fundamentally different: Canada seeks to achieve target fishing mortality rates through catch quota regulation. Although there is stock assessment coordination among the countries, there is no formal mechanism for joint management. The lack of coordinated management efforts has contributed to the severe overfishing of these shared resources.

Economics

Reducing overfishing, as defined by the Multispecies FMP and the Summer Flounder FMP, will require significant effort reductions. Rebuilt stocks will eventually provide increased net benefits to producers and consumers, but in the short term, effort reductions will decrease revenues to fishermen and increase prices to consumers. Bioeconomic analyses of proposed regulations for the Northeast Multispecies FMP indicate reductions in aggregate producer surplus for about five years, followed by substantial gains, as compared with a no-action alternative. Even with an eventual 50% reduction in days-at-sea by the fleet, short-term declines in revenues are only modest, due to price compensation. Consumer surplus declines during the initial stages of the stock rebuilding plan but eventually exceeds the status quo alternative in about 7 years. Net benefits to the nation of the proposed effort reductions for northeast groundfish resources are both positive and substantial.

Progress

Considerable progress in the development of management alternatives for the northeast demersal resources was made during 1992. Measures to take effect in 1994 will include days-at-sea reductions, increased minimum mesh sizes, a moratorium on new vessels, expanded closed areas, and trip limits for depleted haddock stocks. An annual review provision will allow the extent of the effort reduction measures to be changed, depending on the actual levels of fishing mortality as compared with plan targets. Mandatory reporting systems for northeast resources are being developed to track the performance of the fishery better. Revised stock assessments for principal stocks such as cod, pollock, and American plaice have documented patterns of fishing mortality, discarding, and recruitment, and form the basis for proposed regulatory measures.

Management of the summer flounder stock has proceeded with a short-term goal of cutting fishing mortality by 50% from 1992 to 1993 and eventually achieving F_{max}. A series of state-by-state allocations of the annual quota has been the primary regulatory measure. Fishing mortality goals for 1993 are likely to be achieved. Given improved recruitment, coupled with reduced fishing mortality, catch rates for the commercial and recreational sectors have improved in 1993. Lower fishing mortality rates and slightly improved recruitment will result in increased landings and a rebuilding of the spawning stock biomass and its age structure (currently comprised primarily of ages 0-2).

INTRODUCTION

Northeast pelagic or mid-water fisheries are highly seasonal, reflecting the migratory patterns of schooling fishes including Atlantic herring, Atlantic mackerel, butterfish, bluefish, and two species of squids. All of these species winter on the Middle Atlantic shelf and undergo northward and inshore migrations in the spring and summer. Landings are derived with a variety of fishing gears including off-bottom and bottom trawls, gill nets, and seines. Commercial landings of pelagic fishes off the U.S. northeast coast have averaged 142,000 t since 1990, while recreational landings (primarily bluefish and mackerel) in 1992 were about 17,000 t. In 1992, the commercial landings produced about $49 million in dockside revenue, of which the squids accounted for the greatest proportion ($33 million). Bluefish and mackerel are important to recreational fisheries of the region: Approximately $345 million is spent annually to fish for bluefish alone.

Most of the northeast pelagic resources were heavily exploited by foreign fleets during the 1970's, in most cases resulting in rapid declines in stock sizes and yields. Subsequently, however, there has been little U.S. interest in stocks such as mackerel, resulting in rapidly increasing abundance. The pelagic stocks are managed under two Federal FMP's of the Mid-Atlantic Council: the Mackerel, Squid, and Butterfish FMP and the Atlantic Bluefish FMP. Atlantic herring are managed under the auspices of the Atlantic States Marine Fisheries Commission.

SPECIES AND STATUS

The U.S. northeast midwater fisheries are dominated by six species: Atlantic mackerel, Atlantic herring, butterfish, bluefish, and two squids: Long-finned (*Loligo*) and short-finned (*Illex*). Four of the stocks are considered underfished (mackerel, herring, *Illex* squid, and butterfish).

The long-term population trends for herring and mackerel, the principal pelagic species, have fluctuated considerably during the last 25 years (Fig. 2-1). The abundance index reached minimal levels in the mid-1970's, reflecting pronounced declines for both species (as well as the collapse of the Georges Bank herring resource). Both species have been increasing in recent years. Atlantic mackerel recovered during the 1980's, and stock assessments indicate a total stock in excess of 2.5 million t. Mackerel landings in 1992 were very low—only 38,300 t. Although precise estimates of the size of the mackerel stock are not available, clearly the catch could increase several-fold.

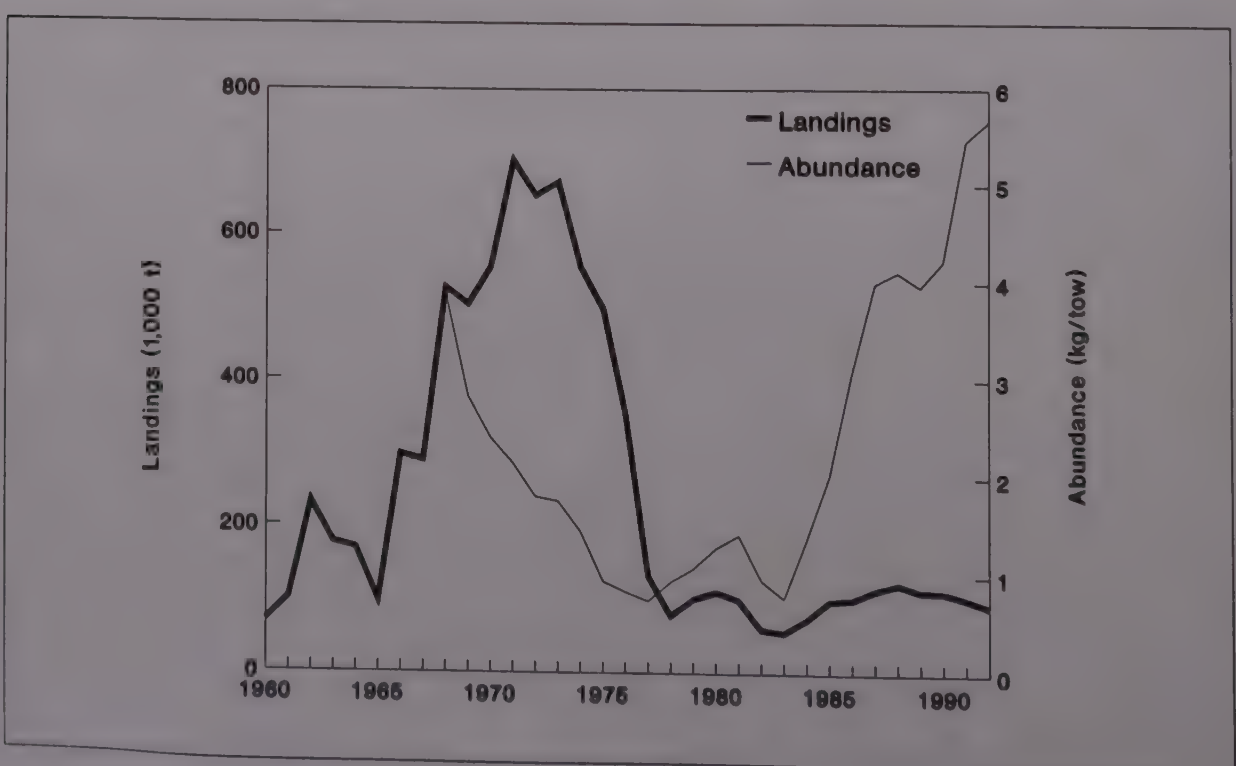


Figure 2-1.—U.S. commercial landings and abundance indices for Atlantic herring and Atlantic mackerel off the northeastern U.S. coast, 1960-92. Abundance indices are mean weight (kg) per tow taken in Northeast Fisheries Science Center (NEFSC) spring bottom trawl surveys. Landings data are for the Georges Bank and Gulf of Maine herring stocks and for the coastwide Atlantic mackerel stock throughout its range.

Growth, maturity rates, and productivity have declined as the stock has grown.

The total Atlantic herring resource off the northeast U.S. is considered underutilized. Total landings from the coastwide Atlantic herring complex of stocks was 91,700 t (U.S. landings were 59,200 t), representing a substantial increase from the 1983 level (36,400 t total by both countries). The coastal stock complex comprises two major stock groups in U.S. waters: Gulf of Maine and Georges Bank. Canadian catches in New Brunswick are also included in the combined stock analysis, since these fish mix with U.S. origin herring during portions of the year. The Georges Bank herring stock was virtually extirpated, following landings of over 370,000 t (1967) and nonsustainable landings levels throughout that period. There is some indication of a recovery of the Georges Bank herring stock, based on U.S. and Canadian bottom trawl surveys and ichthyoplankton investigations and bottom trawl surveys in the region. The entire stock complex is considered to be increasing in abundance.

Of the two squid species, long-finned squid is the most important, due to the significant international export market (primarily to Italy and Spain). Recent research indicates that both squid species have short life spans of roughly one year. Current estimates of long-term potential yields for these species were based upon a longer life span and are being reevaluated. At present, *Loligo* stock biomass is below its long-term average while *Illex* stock biomass is at its long-term average based upon research vessel surveys. Fishing effort for both species has increased in recent years. The availability of both species to fishermen, especially the short-finned squid, changes seasonally.

Butterfish are likewise considered underexploited, based on current research survey results and historic landings patterns. Landings of butterfish have declined significantly in recent years, primarily due to reduced export demand. The stock is currently being fished well below its LTPY (Table 2-1).

Bluefish landings peaked in 1980 at 72,600 t, and have since declined to an average of 25,300 t in recent years (Table 2-1). The majority of total landings (over 80%) are by recreational fishermen. The recent downward trends in recreational and commercial catches, and the continuing decline in the index of abundance based on recreational catch per bluefish trip, suggest that bluefish abundance decreased during the 1980's, and that the stock is fully exploited.

Table 2-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast U.S. pelagic fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) =	470,000 t	(395,157 t, U.S. only)
Current potential yield (CPY) =	640,000 t	(538,087 t)
Recent average yield (RAY)[1] =	168,300 t	(141,500 t)

Species	Yield (t)			Status of	Status of
	RAY[1]	CPY	LTPY	utilization	stock level
Atlantic mackerel[2, 3, 4]	51,400	400,000	200,000	Under	Above
Atlantic herring	57,700	120,000	120,000	Under	Above
Bluefish[3]	25,300	30,000	60,000[5]	Full	Near
Squids					
Long-finned	17,700	44,000	44,000	Under	Below
Short-finned	13,800	30,000	30,000	Under	Near
Butterfish	2,400	16,000	16,000	Under	Above

[1]1990-92 average (including foreign and recreational catches).

[2]Includes more than 100 t of foreign landings (primarily Canadian).

[3]Includes more than 100 t of reported recreational landings.

[4]For mackerel, U.S. landings are only 24,600 t (48%) of the RAY.

[5]Provisional LTPY's, based on historical landings patterns.

ISSUES

Scientific Advice and Adequacy of Assessments

Although historical data on catches and fishing effort are adequate for assessment purposes, stock assessments for northeast pelagic resources are relatively imprecise, owing to the highly variable trawl survey indices of relative abundance used for calibrating cohort models, to the short life span of some stocks (squids and butterfish), and to low exploitation rates of some species. More precise assessments will require the development of hydroacoustic sampling of pelagic fish stocks, combined with trawling surveys to separate the different species components. More precise assessments for short-lived stocks will depend on the availability of more appropriate survey and commercial performance data.

Underutilized Species

All of the pelagic stocks except bluefish are considered underutilized. Recent average yields could be more than doubled and still not reach the long-term potentials. Current potential yields are nearly four times the recent average yields (Table 2.1). Current stock sizes of these underutilized stocks are somewhat uncertain (see above), but nevertheless potential yields substantially exceed current landings, even if conservative stock-size calculations are assumed.

Bycatch and Multispecies Interactions

Concentrations of schooling fish such as the northeast pelagics are utilized by an array of predatory fishes, marine mammals, and birds. In winter months, fisheries targeted at Atlantic mackerel, herring, and squids take some marine mammals including pilot whales and common dolphins. Intensification of these pelagic fisheries to take advantage of these underutilized resources could result in greater marine mammal kills. Current large stock sizes of these pelagic resources may be resulting in increased predation mortality of larval fishes, particularly due to mackerel predation on Georges Bank and in southern New England in late winter and spring.

Scomber scombrus

INTRODUCTION

The anadromous species of the Atlantic seaboard are a diverse group, including river herrings (alewife, blueback herring, hickory shad), American shad, striped bass, Atlantic salmon, sturgeons (Atlantic and shortnose), and rainbow smelt. Regulation of these stocks is likewise diverse: ASMFC has implemented an FMP for river herrings and American shad, while shortnose sturgeon is managed under a recovery plan prepared under the Endangered Species Act. Atlantic salmon are regulated by a New England Council FMP and under the auspices of NASCO. Striped bass are regulated under an ASMFC FMP and special Congressional authority under the Atlantic Striped Bass Conservation Act (implemented by NMFS and USFWS). Current commercial landings of Atlantic anadromous species (Table 3-1; Fig. 3-1 and 3-2) are only about 3,900 t, far below historical levels. Several of the species are or were of major recreational importance to the region (including American shad, striped bass, and Atlantic salmon).

Landings of Atlantic anadromous species have declined greatly in recent years. River herring catches peaked in the 1960's at about 27,000 t coastwide, but have since declined to less than 2,000 t annually. Likewise, commercial landings of American shad had a recent peak of 3,000 t in 1970, but are only about 1,000 t now. Striped bass commercial landings were over 6,000 t in 1973 but decreased to less than 1,000 t by 1985, where they have remained. Recent trends in catches of Atlantic salmon, primarily fish taken in foreign commercial fisheries, are down (to about 6,000 fish), following catches of over 10,000 fish in the 1980's.

Table 3-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic anadromous fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	3,870 t
Current potential yield (CPY) =	3,870 t
Recent average yield (RAY)[1] =	3,870 t

	Yield (t)			Status of	Status of
Species	RAY[1]	CPY	LTPY	utilization	stock level
Alewife	900	Unknown	Unknown	Variable by river	Variable
American shad	900	Unknown	Unknown	Variable by river	Variable
Striped bass[2]	2,000	Unknown	Unknown	Full	Near
Sturgeons	70	Unknown	Unknown	Variable by river	Below
Atlantic salmon	(4,700)[3]	500[4]	Unknown	Full	Below

[1]1990-92 average (including foreign and recreational catches).
[2]Includes significant recreational landings.
[3]Atlantic salmon RAY in numbers of fish, primarily intercepted in distant-water commercial fisheries.
[4]Atlantic salmon CPY in numbers for U.S. waters only.

SPECIES AND STATUS

Unlike most of the offshore resources of the northeast, Atlantic anadromous stocks have been heavily influenced by nonfishing human activities in the coastal zone. Damming of rivers preventing occupation of former spawning grounds was a major factor in the decline of Atlantic salmon, sturgeons, river herrings, and shad. Environmental contamination is implicated in the declines of several of the species. Today, not only are these species threatened by coastal pollution and development, but interception fisheries (sometimes far from the spawning grounds) are considered problematic to the recovery of some species.


American shad
Alosa sapidissima

Atlantic Salmon

Atlantic salmon historically spawned in large river systems throughout New England. As a consequence of industrial and agricultural development, most of the runs native to New England have been extirpated. Today, the only self-supporting runs in the United States are in Maine. Restoration efforts, in the form of stocking and fish passage construction, are underway in the Connecticut, Pawcatuck, Merrimack, and Penobscot rivers. United-States-origin salmon migrate to sea after 2 or 3 years within the rivers. While at sea they generally undergo extensive migrations to waters off Canada and Greenland. The sizes of Atlantic salmon spawning runs in Maine rivers are given with the estimated total (home- and distant-water) catches, in Figure 3-1. Home-water fisheries (those in U.S. waters) are limited to an angling fishery in Maine only. Salmon kept by anglers has averaged 380 fish in recent years, which represents approximately 10% exploitation of the run to Maine rivers. Distant-water fisheries (the commercial gill-net fisheries in Canada and Greenland) have been evaluated by extensive tagging of U.S. origin fish. Harvest estimates from tagging studies put exploitation rates of U.S. fish at approximately 60% in these oceanic fisheries. These commercial oceanic fisheries are regulated under the auspices of NASCO. Canadian interception fisheries have been regulated by time-area restrictions and quotas; beginning in 1992, the fishery in Newfoundland was closed for a 5-year period. The Greenland fishery is quota-controlled.

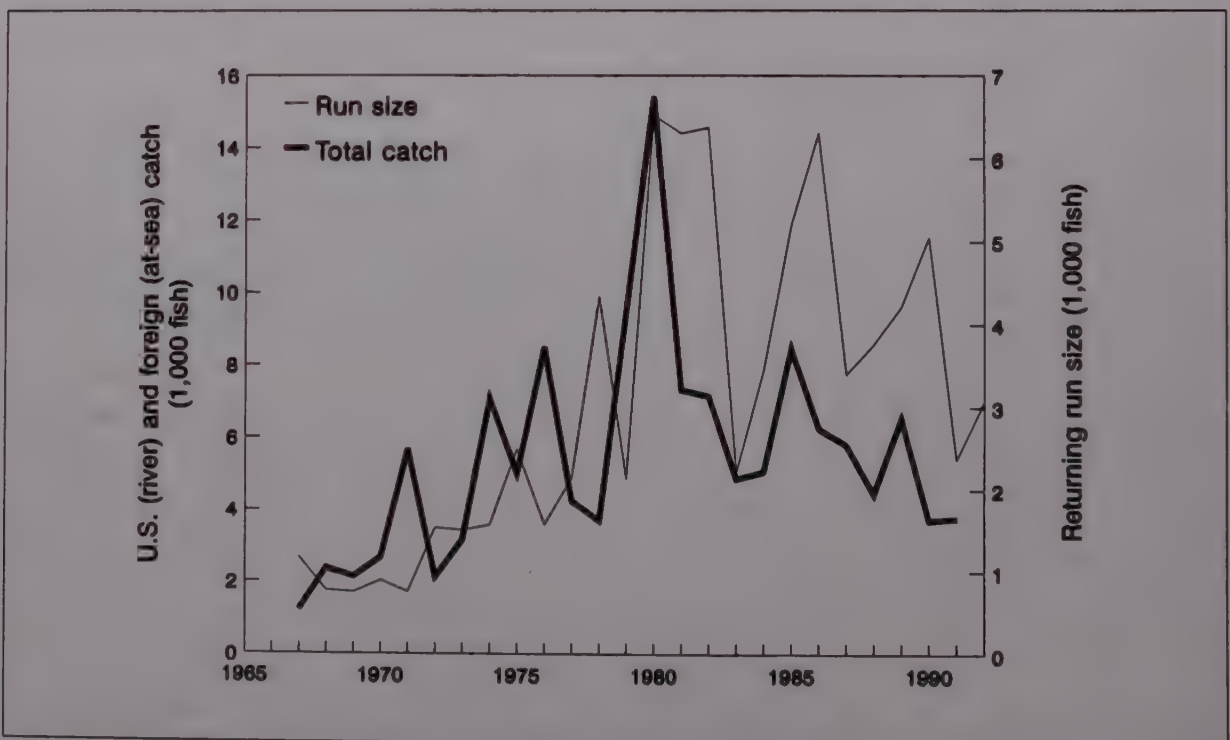


Figure 3-1.—Estimated sizes of spawning runs of Atlantic salmon returning to Maine rivers (numbers of fish), total catch by U.S. anglers from those rivers, and at-sea foreign commercial harvest, 1967-92. The foreign salmon catch is estimated from data on tagged and recaptured salmon.

Striped Bass

Three primary stocks of striped bass occur along the Atlantic coast: Hudson River, Chesapeake Bay, and Roanoke River (N.C.). Striped bass stocks historically have supported important commercial and recreational fisheries, with recreational harvests often equalling or exceeding commercial landings (Fig. 3-2). Commercial fisheries are prosecuted with a variety of gears including haul seines, trawls, pound and gill nets, and hook-and-line. Commercial landings peaked in 1973, and then began a precipitous decline. The declining landings coupled with consistently poor recruitment indices in the Chesapeake Bay provided an impetus for highly restrictive management actions taken by ASMFC in the mid-1980's. Additionally, Congress passed the Atlantic Striped Bass Conservation Act, which empowered the Departments of Commerce and Interior to impose a moratorium on striped bass fishing in any state which ASMFC found not to be complying with its FMP.

In 1989 a high recruitment index in the Chesapeake Bay (Fig. 3-2) triggered a

... Striped Bass

slight relaxation of management restrictions and allowed increased fishing pressure on migratory Atlantic striped bass stocks, beginning in 1990. The fisheries are being closely monitored and remain severely restricted. Modeling studies indicate that stocks should continue to recover if fishing annually removes 22% or less of the legal-sized fish.

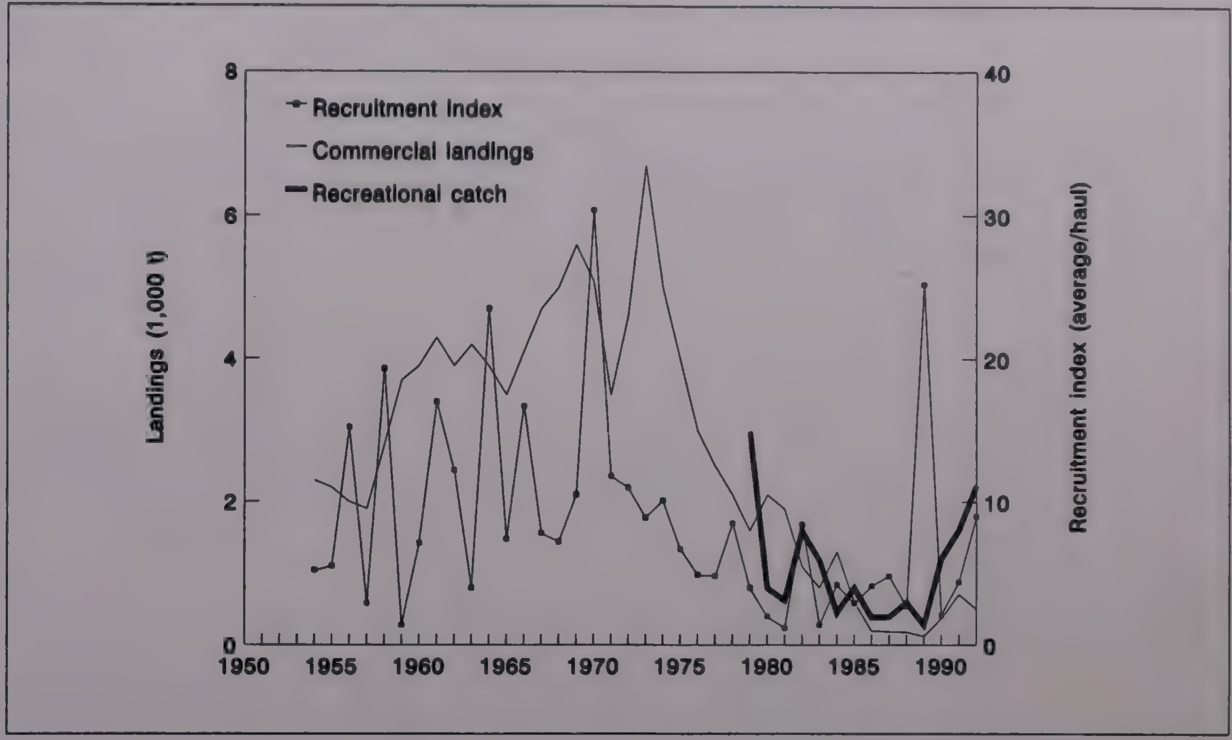


Figure 3-2.—Striped bass catches in commercial and recreational fisheries and the recruitment index (Maryland "seine index") of young striped bass abundance in the Chesapeake Bay, 1954-92. The recruitment index is the average catch per seine haul.

ISSUES

Transboundary Stocks and Jurisdiction

The interception of U.S. origin Atlantic salmon in commercial fisheries off Canada and West Greenland represent a major impediment to the restoration of runs and homewater fisheries. The catch in interception fisheries of U.S. origin fish has been about 10 times the home-water recreational catch. Beginning in 1992, the largest portion of the Canadian fishery, that around Newfoundland, was closed for a 5-year moratorium. In June of 1993, a new 5-year agreement on setting quotas for Atlantic salmon in the west Greenland fishery was established by the North Atlantic Salmon Conservation Organization (NASCO). Based on a scientific model using ocean environmental data developed by the assessment working group, the abundance of salmon was predicted and catch quota options were provided. The agreed quotas were designed to insure that sufficient spawners return to the rivers. Subsequent to the negotiation of the quota agreement, a private initiative was successful in purchasing the 1993 quota (for the purposes of stock protection) for a 2-year period, with the exception of a small fishery for local use.

Habitat Concerns

The passage of Atlantic salmon smolts downstream and of returning adults around dams is problematic to achieving significant wild-run spawning in many rivers. Additionally, many riverine habitats which historically produced juvenile salmon are not of sufficient environmental quality now to support salmon reproduction. A scenario of long-term climate change may have considerable influence on Atlantic salmon throughout its range, since juvenile survival and adult feeding distributions appear to be mediated by the distribution of sea water temperatures. Additionally, warmer sea temperatures may negatively influence reproduction in U.S. rivers, which are at the extreme southern geographic limit of the species' range.

Management Concerns

An issue of particular concern for striped bass is the potential impact of hook-and-release fishing. Recreational fishing effort for striped bass currently far exceeds commercial effort, and, since the late 1980's, over 90% of the recreational catch has been released alive. If survival rates of hooked and released striped bass are low, then hooking mortality may seriously compromise the conservation benefit of high minimum sizes. Another concern is the effect of poor water quality on larval survival in Chesapeake Bay. Restrictive management measures have been successful in rebuilding the severely depleted spawning stocks in the Bay. However, if poor water quality prohibits survival of young bass, striped bass restoration will remain threatened.

The endangered species status of Atlantic salmon populations in the northeastern United States is also being considered. At issue are runs in both small and large rivers and the status of restoration stocks.

INTRODUCTION

Offshore fisheries for crustaceans and bivalve mollusks are among the most valuable of the region's fisheries. In 1992, landings of American lobster (25,300 t) and sea scallop (14,200 t) (Table 4-1) gave ex-vessel revenue of $161 million and $152 million, respectively. The combined revenue from these two fisheries exceeds that for all offshore finfish fisheries combined. Additionally, landings of surfclam, ocean quahog, and northern shrimp contributed a total of $62 million in revenue in 1992. These fisheries are generally single species in nature; only the sea scallop and northern shrimp fisheries generate significant bycatch. Four separate fishery management regimes regulate the harvest of these species; the Surfclam/Ocean Quahog FMP of the Mid-Atlantic Council and the Sea Scallop FMP of the New England Council are Federal plans. The northern shrimp fishery is regulated by the Atlantic States Marine Fisheries Commission. American lobsters in territorial waters are regulated by individual states and in the EEZ under a Federal FMP. A comprehensive inshore/offshore management framework is currently under development by the ASMFC and the New England FMC.

Table 4-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast invertebrate fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum.

Long-term potential yield (LTPY) =	100,200 t	(94,670 t, U.S. only)
Current potential yield (CPY) =	104,700 t	(98,921 t)
Recent average yield (RAY)[1] =	106,900 t	(101,000 t)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Surfclam[2]	32,100	32,600	Unknown	Full	Above
American lobster	27,100	27,600	Unknown	Over	Above
Ocean quahog[2]	22,100	22,700	22,700	Full	Near
Sea scallop[2, 3]	21,900	17,400	13,300	Over	Near
Northern shrimp	3,700	4,400	4,000[4]	Full	Near

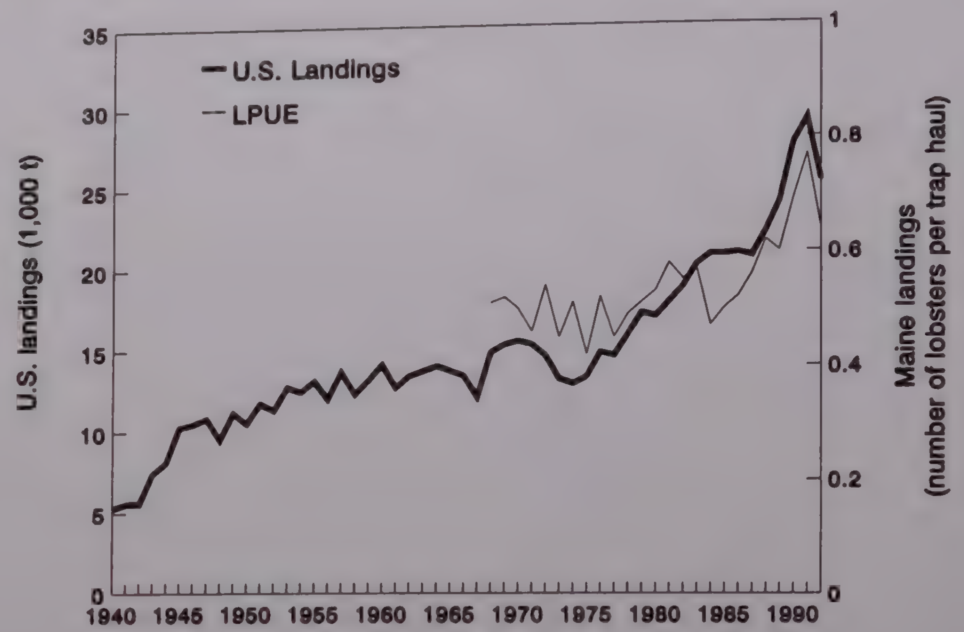
[1]1990-92 average.
[2]Data for bivalve species are in shucked meat weights.
[3]Transboundary stock with Canada, which harvests 26% (5,700 t) of RAY.
[4]Provisional LTPY, based on historical landings patterns.

SPECIES AND STATUS

American Lobster

Lobsters are partially regulated under an FMP promulgated by the New England Council. Because most of the lobster harvested are taken within state territorial waters, state regulations apply to most catches. American lobster populations are regulated primarily by minimum carapace length ("gauge"), currently set at 3¼" (83 mm). The intent of management is to increase egg production/recruit for lobster, as a large fraction of all lobsters landed are juveniles. Comprehensive stock assessments of American lobster resources were completed in 1993. These assessments indicated that the Gulf of Maine resource was exploited at a rate about 20% above the New England Council's overfishing level. The portion of the resource inshore from Cape Cod through Long Island Sound is substantially overfished, while the offshore continental shelf portion of the resource was being exploited at approximately the overfishing level. The New England Fishery Management Council, in combination with the Atlantic States Marine Fishery Commission, is now evaluating management alternatives to reduce fishing mortality rates. U.S. lobster catch and landings per unit effort data are given in Figure 4-1.

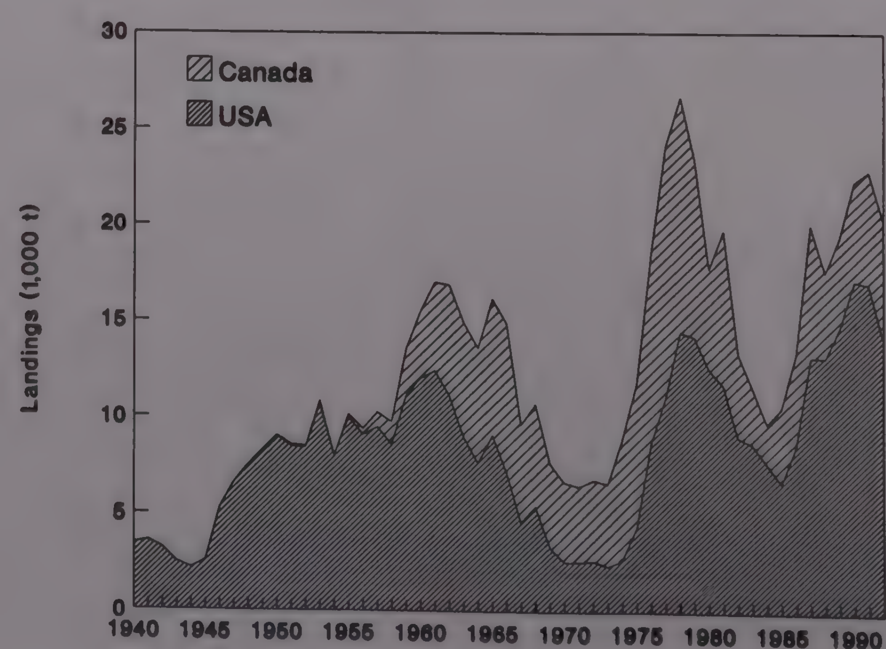
Figure 4-1.—U.S. American lobster landings, 1940-92, and the landings per trap haul (LPUE) in Maine coastal waters during that period. In 1992, Maine produced 48% of the U.S. landings of the species.



Sea Scallop

Sea scallops are harvested on the continental shelf from the Virginia Capes to the Hague Line, separating U.S. and Canadian portions of Georges Bank, and in the Gulf of Maine. Canadian landings on Georges Bank represent a significant fraction of the total (Fig. 4-2). Sea scallops are primarily harvested using dredges; small quantities of landings are derived with trawl nets and by divers (in the Gulf of Maine). The Sea Scallop FMP of the New England Council regulates the fishery primarily on the basis of maximum meat-count regulations (numbers of scallop meats per pound) intended to minimize the harvest of small animals. Sea scallop populations are characterized by large variability in year-class strength. U.S. landings in 1991 were a record high, but landings declined in 1992 (by 16%), reflecting poorer recruitment. Landings in 1993 are expected to decline significantly. Sea scallops are partially recruited to the fishery at age 3 and fully recruited at age 4. Over 60% of age 4 and older scallops are harvested from the resource each year. Given the rapid growth

Figure 4-2.—U.S. and Canadian landings of Atlantic sea scallops from the Mid-Atlantic, Gulf of Maine, and Georges Bank regions, 1940-92.



. . . Sea Scallop

and low natural mortality rates, considerable yield is currently being foregone to growth overfishing. Current fishing mortality rates also greatly exceed recruitment overfishing definitions.

Surfclam and Ocean Quahog

Surfclam and ocean quahog are harvested with hydraulic dredging vessels; the majority of EEZ landings occur off New Jersey and the Delmarva Peninsula. Small quantities of surfclam and ocean quahog are also caught in southern New England and the Gulf of Maine. Fisheries for these species are currently closed on Georges Bank due to paralytic shellfish poisoning (PSP) contamination. Surfclam and ocean quahog are managed under the Surfclam and Ocean Quahog FMP of the Mid-Atlantic Council. The primary management measure is a system of individual transferrable quotas allocated on the basis of historical participation in the fisheries. Atlantic surfclam landings increased steadily during the 1960's and early 1970's, peaking in 1974. Subsequently, a succession of poor year classes, combined with a large die-off of the surfclam resource off the New Jersey coast in 1976, led to very low stock biomasses and reduced landings. Beginning in 1977, the FMP has regulated total annual surfclam landings from the EEZ (where most landings are derived) and has addressed the significant overcapitalization in the fishery. Large year classes spawned in 1976 and 1977 off New Jersey and the Delmarva Peninsula now comprise the bulk of the harvestable biomass of the stock. Under current harvest rates (less than 10% per year) there is sufficient harvestable biomass to support the present quota levels well into the 1990's.


Atlantic surfclam
Spisula solidissima

Ocean quahog landings increased rapidly as the surfclam resource collapsed in the mid-1970's, and a market substitute for processed clam products developed. Ocean quahogs inhabit relatively deep (40-100 m) waters of the Mid-Atlantic continental shelf and on Georges Bank. In the Gulf of Maine they are found relatively near shore. The species is extremely slow growing, and ages in excess of 100 years are common in the populations (particularly in the Mid-Atlantic region). Current annual landings have been maintained at less than 2% of the estimated standing stock of the species, in recognition of its low annual productivity.

Northern Shrimp

Northern shrimp are harvested exclusively from the Gulf of Maine in small-mesh trawl fisheries. Northern shrimp are at the southern extent of their geographical range in U.S. waters. ASMFC regulates the northern shrimp fishery in the Gulf of Maine; regulations control the length of the harvesting season (December to May) and the gear to be used.

ISSUES

Management Concerns

Fishing mortality rates on sea scallops are far in excess of those generating maximum cohort yields and exceed recruitment overfishing reference points. The New England FMC has developed a plan amendment aimed at reducing fishing mortality on sea scallop. Measures include reductions in fishing effort through limiting days-at-sea and a moratorium on vessel entrants, while removing the meat-count requirement. The current meat count regulations do little to control the overall rate of fishing mortality but do offer some protection to partially-recruited age 3 scallops. In the absence of such regulations, or their equivalent to minimize catch of small animals, fishing mortality rates would likely be even greater than at present. The Council proposal includes an increase in the minimum "ring size" in the chain bag of scallop dredges, as a means to reduce the catch of small scallops and to compensate for the removal of the meat count requirement.

Management of American lobsters is complicated by the international trade in live lobsters between Canada and the United States. Conformity of imports with U.S. minimum gauge limits is a major political issue confronted in attempting to increase spawning potential for the stocks. The fact that the fishery is almost exclusively supported by recently molted animals is a source of serious concern for the long-term health and stability of these fisheries.

Bycatch and Multispecies Interactions

The trawl fishery for northern shrimp has in the past generated considerable bycatch and associated discard of groundfish in the Gulf of Maine region. Increased concern over the fate of groundfish resources led to the adoption of a fish excluding device (the "Nordmore Grate") as a condition of participation in this fishery. Sea sampling effort has been intensified to determine the impact of use of this technology on bycatch rates of groundfish. Bycatch of goosefish in the sea scallop fishery has come under increased scrutiny as a possibly significant source of fishing mortality on the goosefish stock, and particularly on very small goosefish.

Progress

An important issue in the surfclam-ocean quahog fishery was the implementation of an ITQ system, which obviated the need for complex restrictions on the amount of fishing time allotted to each surfclam vessel. The total surfclam fleet has been reduced substantially since implementation of the ITQ system, from about 160 to less than 100 vessels in the first year alone. In the future there is likely to be further consolidation of fishing on a smaller number of vessels, as well as construction of new and more efficient vessels to reduce overhead.

Considerable progress in assessment of exploited invertebrate stocks of the northeast region has been made in the past year. Traditional age-based assessment techniques have not been applied to American lobster and sea scallop, since aging of these animals is difficult. Methods based on length measurements alone, or in combination with limited aging, have been developed to produce estimates of fishing mortality for these resources. The development of these techniques emphasizes the importance of obtaining reliable biological sampling of the catches for length composition. Biological sampling of these stocks remains problematic, since, in the case of sea scallop, the product is partially processed at sea. An integrated assessment of combined inshore/offshore lobster stocks was completed by NMFS and state scientists. This new assessment will be the basis for evaluating management alternatives, as direct controls on fishing mortality are being considered for this fishery.

INTRODUCTION

Oceanic pelagics are highly migratory species that include swordfish, bluefin tuna, yellowfin tuna, bigeye tuna, albacore, skipjack tuna, blue and white marlin, sailfish, longbill spearfish, and other minor fishes. In the Atlantic Ocean, swordfish and bluefin tuna have long provided important fisheries, while in recent years yellowfin tuna have increased in importance to U.S. fishermen. Many recreational anglers target yellowfin and bluefin tuna, blue marlin, white marlin, and sailfish in U.S. waters and occasionally longbill spearfish. Commercial fishing for billfish species in U.S. waters is now banned; however, they may be incidentally caught in tuna and swordfish longline fisheries.

Skipjack tuna
Katsuwonus pelamis

Since Atlantic oceanic pelagics migrate widely and are harvested over broad oceanic areas by U.S. and foreign fishermen, both national and international management are necessary. In all cases, stock assessments based on aggregate data provide the bases for regulations. U.S. fleets fish in the northwestern Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. These fleets are regulated under the Magnuson Fishery Conservation and Management Act and the Atlantic Tunas Convention Act (ATCA), which provides authority to implement international agreements reached by the International Commission for the Conservation of Atlantic Tunas (ICCAT). U.S. fishery management plans have been developed for swordfish, blue marlin, white marlin, sailfish, and spearfish under the MFCMA. Management of Atlantic tunas and swordfish has been based largely on ICCAT recommendations. The Commission has set and allocated bluefin tuna quotas by country since 1982. Swordfish quotas were implemented in the U.S. beginning in 1991.

SPECIES AND STATUS

From the early 1960's through 1977, U.S. fishermen averaged about 5,000 t per year (2,000-12,000 t/year) of oceanic pelagics (Fig. 5-1). Since 1978, U.S. fishermen have caught 8,000 t or more per year, and during 1988-90 they averaged 16,512 t/year. However, the U.S. share of the estimated current potential yield of oceanic pelagics is 13,550 t/year, and the long-term potential yield to the U.S. fleet is estimated at 19,200 t/year (Table 5-1).

Since 1960, the top species by volume in the U.S. harvest has shifted from bluefin tuna to swordfish to yellowfin tuna (Fig. 5-1) as each species became increasingly fished down. During 1961-73, bluefin tuna represented 45-80% of the U.S. western Atlantic large pelagic catch. But since 1977, the percentage has dropped to less than 10%, reflecting the decline in the bluefin tuna population (Fig. 5-1), catch restrictions, and the increasing harvests of alternate species. During 1961-73, swordfish represented 5-20% of the large pelagic catch, rose to 60% in 1982, but has since dropped to about 33% (Fig. 5-1). During 1961-83, the percentage of yellowfin tuna in the U.S. North Atlantic large pelagic catch was usually less than 10%, but that has since risen to 45%.

The U.S. dockside ex-vessel revenue from these fishes soared from about $20 million (early 1980's) to nearly $100 million in 1988. During 1989-91, the average annual dockside ex-vessel revenue was $96.5 million.

Angler harvests of large pelagic fishes are estimated from dockside and telephone surveys. The average annual catch by recreational anglers for 1989-91 is conservatively estimated at 1,800 t. Fishing tournament surveys indicate a substantial increase in billfish fishing since 1972, though there are no precise data on these recreational anglers. Billfish tournament growth in some southern states indicates a fivefold to tenfold increase in this fishery since 1972. Although the practice of tagging and releasing of large pelagics has grown in recent years, more data are needed to quantify the recreational fishery trends for these fishes in the U.S. Atlantic and Gulf waters.

There are few Atlantic large pelagic

. . . SPECIES AND STATUS

species that appear to be underutilized and several that are far overutilized. Bycatch of blue and white marlin by domestic and foreign fleets directing effort at other species has resulted in overharvesting of these stocks. Fishing mortality rates of swordfish have been excessive in recent years, prompting the development of international agreements to substantially reduce catches beginning in 1991. Recent harvests since July 1991 are consistent with ICCAT recommendations designed to reduce the risk of further declines. Western Atlantic bluefin tuna have been overharvested to the point of being severely depleted, and as a result the harvest of this valuable species has been restricted since 1982. In spite of the current restrictions, there has been no apparent increase in adult numbers.

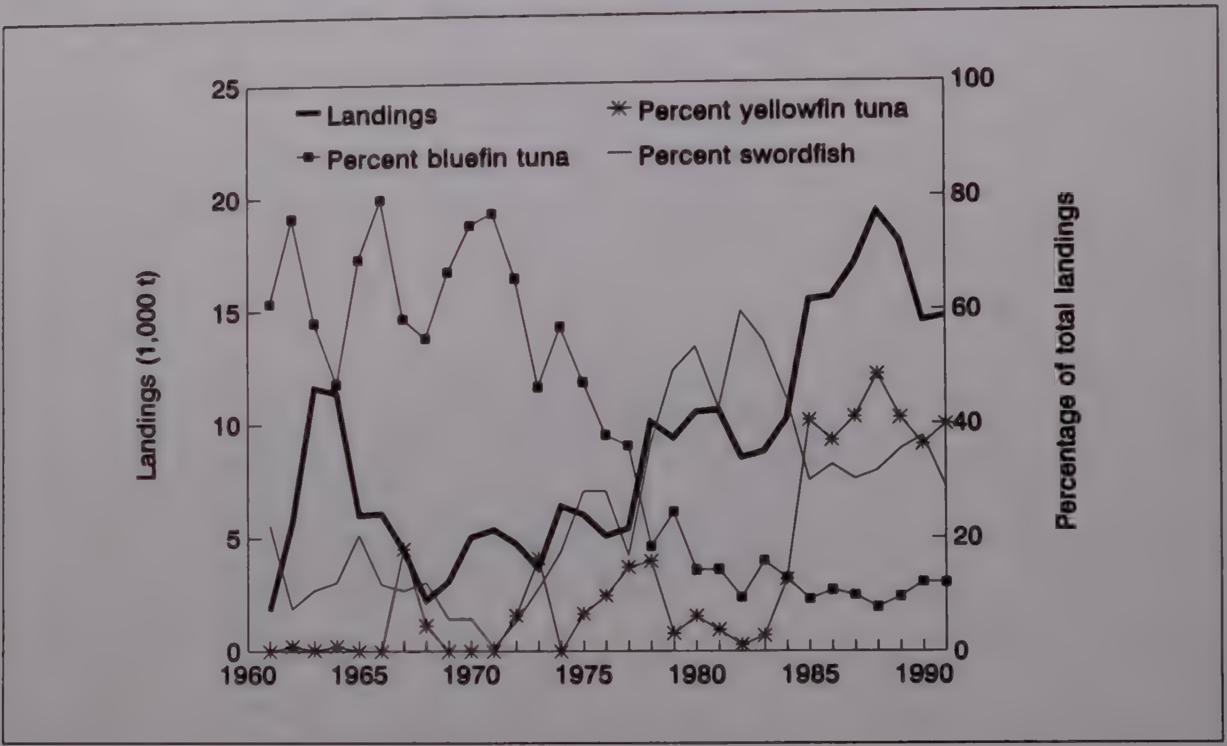


Figure 5-1.—U.S. landings of tunas, swordfish, marlins, sailfish, and spearfish from the western North Atlantic Ocean, and the percentage of the total landings made up of the primary species (bluefin and yellowfin tuna and swordfish), 1961-91.

Table 5-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic highly migratory pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY)[1] =	246,919 t	(19,200 t, U.S. only)
Current potential yield (CPY)[1] =	223,455 t	(13,550 t)
Recent average yield (RAY)[1,2] =	228,955 t	(15,950 t)

Species and area	Yield (t) RAY[2,3]	CPY[2]	LTPY[2,3]	Status of utilization	Status of stock level
Bigeye tuna (Atlantic)	69,200	Unknown	67,500	Full	Near
Albacore (N. Atlantic)	31,000	Unknown	38,000	Full	Near
Yellowfin tuna (W. Atlantic)	30,000	Unknown	33,000	Possibly Full	Unknown
Skipjack tuna (W. Atlantic)	26,900	Unknown	33,000	Possibly Full	Near
Swordfish (N. Atlantic)	15,300	11,500	14,200	Over	Below
Bluefin tuna (W. Atlantic)	2,900	1,200	6,700	Over	Far Below
Billfishes					
Blue marlin (N. Atlantic)	1,183	Unknown	1,700	Over	Below
White marlin (N. Atlantic)	253	Unknown	600	Over	Far Below
Sailfish (W. Atlantic)	619	Unknown	Unknown	Unknown	Unknown
Other tunas (Atlantic)	51,600	Unknown	Unknown	Unknown	Unknown

[1]Total LTPY, CPY, and RAY under present fishing patterns by U.S. and foreign nationals.

[2]1989-92 average.

[3]Individual LTPY's, CPY's, and RAY's based on entire stock, regardless of harvesting nation.

ISSUES

Transboundary Stocks

Regulation of species that migrate across international boundaries is always difficult. Domestic regulation without international agreements is inherently limited, but international agreements can be difficult to achieve. The latter is particularly true if the primary fishing nations cannot agree on fishing and conservation objectives. Some nations see such rules as too restrictive of short-term gains, while others see them as too lax for long-term conservation.

For example, swordfish and bluefin tuna occur on both sides of the Atlantic. Both are assessed and managed through ICCAT, with swordfish being treated as a single stock and bluefin tuna as two stocks (western and eastern Atlantic). These assumptions about stock separation are still highly controversial.

Bycatch and Multispecies Interactions

Marlin and sailfish bycatches in tuna and swordfish fisheries are a major concern, especially as commercial fisheries move onto concentrations of billfishes important to recreational anglers.

Expansion of the U.S. longline fishery for Gulf yellowfin tuna and Spanish longline fishing in the tropical eastern Atlantic have heightened concern for distressed Atlantic tunas, swordfish, and the billfishes sought by recreational anglers.

Progress

A Highly Migratory Species Management Division was established at NMFS headquarters in 1991 to coordinate management of these stocks with the regions, councils, and ICCAT commissioners. Catch quotas for swordfish were implemented in the same year and subsequently adjusted in 1992 and 1993 to reflect resource assessment results from ICCAT. Bluefin tuna regulations on quota reductions, bycatch, angler permits and bag limits, and seasonal closures have been modified in efforts to meet ICCAT recommendations to reduce 1983-91 harvest levels by 10% in 1992-93, a further 15% in 1994, and 30% in 1995, for a total reduction of 55%. To improve monitoring of the fishery, the angling survey was expanded significantly to cover as much of the fleet as possible. Both private and charter vessels were included and quota monitoring improved accordingly.

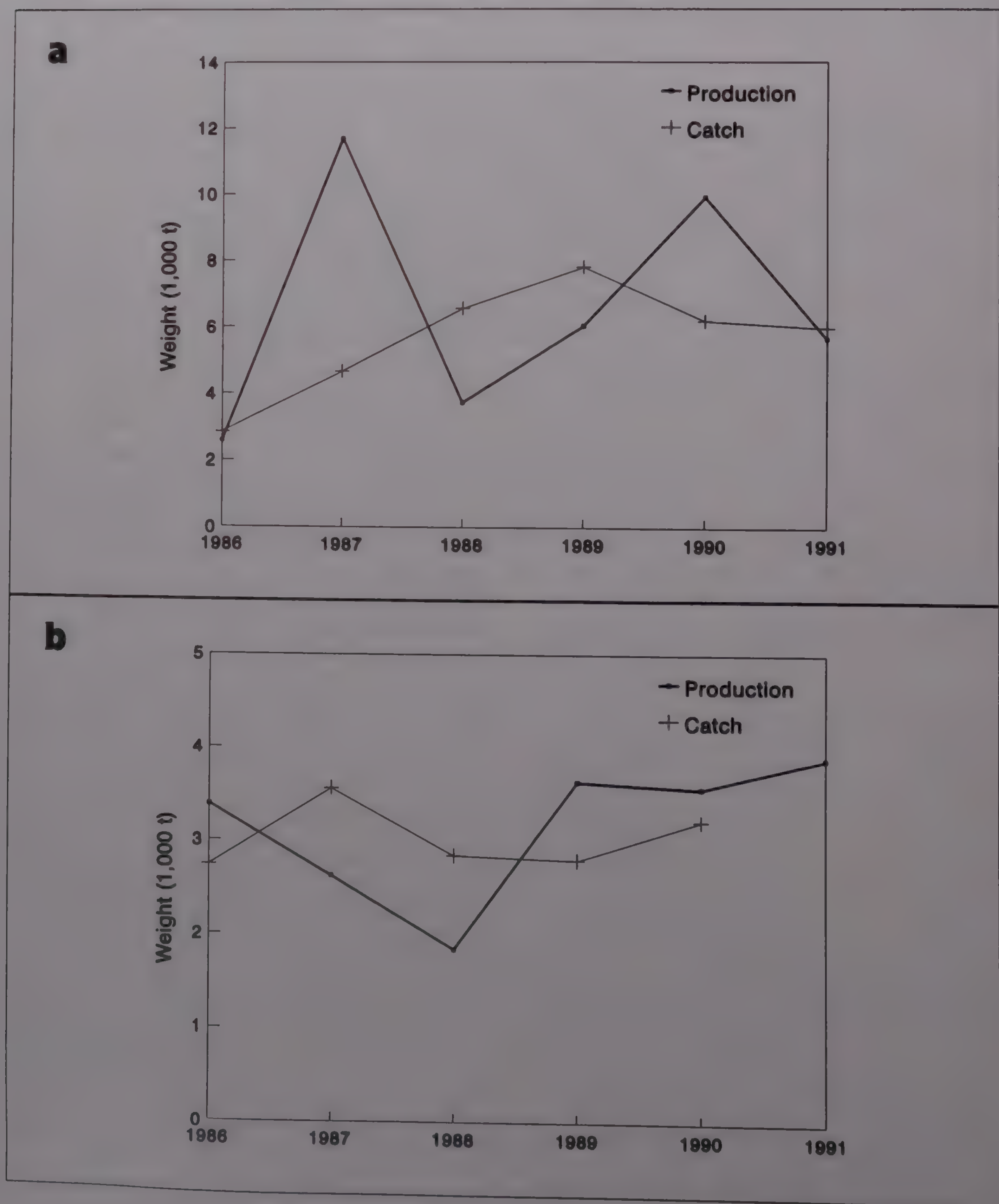
ATLANTIC SHARK FISHERIES

INTRODUCTION

About 350 species of sharks are known worldwide. Of those, 72 frequent waters of the U.S. Atlantic, Gulf of Mexico, Puerto Rico, and U.S. Virgin Islands. For many years sharks were fished moderately and only in limited coastal areas. In recent years, however, large coastal sharks have been intensively fished over broad geographic areas. Sharks were first fished primarily for their livers (for vitamin A) and hides (for leather). Other minor products were fresh and salted meat, dried fins for Oriental sharkfin soup, and fish meal. The appearance of low-cost, synthetic vitamin A ended some of the small shark fisheries in 1950, and there was little demand for shark flesh or other products in the United States before 1970. In the 1980's, however, shark has become popular due to better handling, marketing, promotion, and an economy favoring low-cost shark over more expensive fish (Fig. 6-1).

Shark fishery management regulations are stipulated in a shark fishery management plan developed by the National Marine Fisheries Service for the Secretary of Commerce.

Figure 6-1.—Production and catch of Atlantic and Gulf of Mexico large coastal sharks (a) and small coastal sharks (b).



SPECIES AND STATUS

Under the Magnuson Fisheries Conservation and Management Act, U.S. Atlantic sharks were divided into three management groups (Table 6-1): 1) Large coastal sharks (white, tiger, lemon, smooth and great hammerhead, basking, whale, blacktip, sandbar, reef, dusky, spinner, silky, bull, bignose, Galapagos, night, raggedtooth, nurse, and scalloped); 2) small coastal sharks (Atlantic and Caribbean sharpnose, finetooth, blacknose, bonnethead, and Atlantic angel); and 3) pelagic sharks (longfin and shortfin mako, blue, porbeagle, thresher, bigeye thresher, oceanic whitetip, sevengill, sixgill, and bigeye sixgill).

Both U.S. recreational and commercial shark fishermen seek coastal sharks along the Atlantic seaboard. Pelagic sharks are targeted by tournament anglers, particularly off the Mid-Atlantic states, and are incidentally caught by swordfish and tuna longliners. The dockside ex-vessel revenue of the commercial shark fisheries has averaged more than $7 million annually in recent years.

Anglers fish for sharks on both tournament and nontournament trips, the latter being the more prevalent. Nontournament anglers usually catch small coastal sharks that are generally not targeted by commercial fisheries. However, commercial and recreational fishermen can affect the shark fishing of each other. The Gulf of Mexico shrimp fishery catches and discards many small coastal sharks (mostly sharpnose). Also, headboat anglers depend on blacktip sharks, a species seasonally taken by longline and drift gillnet fishermen. Many southern shark tournament anglers also fish for the same large coastal species taken by commercial fishermen. Tournament anglers farther north (Mid-Atlantic states and southern New England) fish for shortfin mako and blue sharks that are caught incidentally by large pelagic longline fisheries. In another twist, sharks taken by anglers along the Atlantic and Gulf coasts are often sold to commercial fish buyers (in 1986 about 9% of the "commercial" landings were taken by rod-and-reel fishermen).

Meanwhile, a mobile longline fishery targets large coastal sharks in both Atlantic and Gulf waters, taking several species important to anglers. Fish buyers prefer sharks of 15-50 pounds (dressed weight), but larger sharks have been killed just for their fins.

Other boats use gill nets, including drift gill nets, for blacktip shark near shore in late summer and early autumn. Gulf snapper-grouper boats, particularly bottom longliners, also land sharks. Many sharks caught by Gulf shrimp trawlers are discarded at sea (though fins may be saved), but large valuable sharks are kept and sold.

White shark
Carcharodon carcharias

Table 6-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic sharks. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	9,730 t
Current potential yield (CPY) =	7,630 t
Recent average yield (RAY)[1] =	9,530 t

Species and area	Yield (t) RAY	CPY	LTPY	Status of utilization	Status of stock level
Large coastal sharks[2]	3,800	1,900	3,400	Over	Below
Small coastal sharks[3, 4]	3,000	3,000	3,600	Fully	Above
Pelagic sharks[5]	2,730	Unknown	Unknown	Unknown	Unknown

[1] 1988-90 average.

[2] Includes sandbar, reef, blacktip, dusky, spinner, silky, bull, bignose, Galapagos, night, tiger, lemon, ragged-tooth, nurse, scalloped, smooth and great hammerhead, whale, basking, and white sharks.

[3] Includes Atlantic and Caribbean sharpnose, finetooth, blacknose, bonnethead, and Atlantic angel sharks.

[4] Almost all of the small coastal shark yield is caught as bycatch in the Gulf shrimp fishery and discarded at sea.

[5] Includes longfin and shortfin mako, blue, porbeagle, thresher, bigeye thresher, oceanic whitetip, sevengill, sixgill, and bigeye sixgill sharks.

. . . SPECIES AND STATUS

Many sharks are also caught in the pelagic swordfish and tuna longline fishery. Some sharks are discarded at sea, though certain species such as shortfin mako are regularly landed owing to their market value.

The data available on shark fisheries are very limited. Many species are landed and classified only as "shark" by fishermen and dealers in the market. To overcome some of these data deficiencies, newly developed assessment models were applied to the data available to generate assessment information by group: Large coastal sharks are considered overutilized; small coastal sharks are considered fully utilized. There is insufficient information to assess the status of pelagic sharks.

ISSUES

Scientific Information and Adequacy of Assessments

Many species of shark are fished and many are difficult to distinguish. The market generally does not categorize sharks by species. This complicates scientific analysis, although assessments for groups of species have been made. There is a critical lack of data on shark numbers, biology, distribution, life history, and harvest. Without such data, it is difficult to assess the status of particular species.

Management Concerns

Recreational and commercial fishermen have both voiced concern about declining shark populations. Because sharks grow and reproduce slowly, they are very vulnerable to overfishing.

Progress

A new fishery management plan has been developed by NMFS for sharks and was implemented in 1993. It regulates commercial and recreational shark fishing to prevent overfishing, prohibit the practice of finning, discourage discarding of shark carcasses, rebuild currently overfished stocks, and improve data collection and

ATLANTIC/GULF OF MEXICO COASTAL MIGRATORY PELAGIC FISHERIES

INTRODUCTION

Coastal pelagic fishes inhabiting waters off the southeastern United States include king mackerel, Spanish mackerel, cero, dolphin, and cobia. These species range in coastal and continental shelf waters from the northeastern United States through the Gulf of Mexico and the Caribbean Sea and as far south as Brazil. Coastal pelagics are fast swimmers that school and feed voraciously, grow rapidly, mature early, and spawn over many months.

U.S. and Mexican commercial fishermen have fished Spanish mackerel since the 1850's and king mackerel since the 1880's. The Spanish mackerel fishery began off New York and New Jersey but shifted southward through the decades to the southern U.S. Atlantic and Gulf of Mexico. In 1990, over 90% of the commercial catch was landed in Florida. Although early commercial fisheries harvested Spanish mackerel by hook and line, nearly all the commercial catch now is taken by run-around gill net. A recreational fishery also exists for Spanish mackerel and accounts for about 25-42% of all the Spanish mackerel landed.

King mackerel are commercially fished from Chesapeake Bay southward. Four major production areas exist: North Carolina; lower Florida east coast (Cape Canaveral to Palm Beach); the Florida Keys; and Grande Isle, La. The Louisiana fishery began in the early 1980's; the area was believed to harbor older females that served as a major spawning population for Gulf of Mexico king mackerel. Unconstrained fishing mortality was believed to be high on these fish during the early 1980's, and these stocks currently comprise about 31% of the commercial quota for the Gulf regulatory group. Landings, which approached 1.5 million pounds in 1983, were reduced one-half to two-thirds by Federal quota management from the mid-1980's to present.

The commercial king mackerel vessels through the years have employed gill nets, troll lines, handlines, purse seines, otter trawls, and pound nets. King mackerel sport fisheries exist off many southeastern states throughout the year. Commercial yields were mostly unregulated until the mid-1980's. Recreational landings are thought to have been reduced by an expanding commercial run-around gill net fishery in the 1970's and a driftnet fishery in the late 1980's.

Coastal pelagics are co-managed under the Coastal Migratory Pelagic Resources Fishery Management Plan and regulations adopted by the South Atlantic and Gulf of Mexico Fishery Management Councils and implemented by NMFS. Total allowable catch and commercial and recreational allocations are established for two distinct migratory groups of king and Spanish mackerel, the Gulf group and the Atlantic group. Acceptable biological catches are estimated for separate geographical areas within the Gulf migratory group. Quota management began in the 1985-86 fishing year. Presently both commercial and charterboat operators must hold Federal permits to fish for king mackerel, Spanish mackerel, or other coastal pelagics. Recreational catches are regulated by creel and size limits. In addition to quota limits, commercial catches must comply with minimum size restrictions, and off some states, daily landing limits and/or trip limits apply. Currently only U.S. fishermen are regulated, although Mexican catches are thought to be large.

SPECIES AND STATUS

Recreational fishermen caught 8,000-17,000 t/year of coastal pelagic species, and commercial fishermen caught 5,000-14,000 t/year during 1979-91 (Fig. 7-1). King and Spanish mackerel account for about 95% of all coastal pelagic species harvested. In addition to king and Spanish mackerel, Atlantic dolphin and cobia contributed significantly to the total recreational yield of coastal pelagics. Some cobia are incidentally caught by commercial mackerel fishermen. Cero are relatively unimportant and are usually taken in other fisheries. Cero are not known to form large schools and are more difficult to target as a single species; in general they do not contribute significantly to coastal pelagic catches.

As a group, coastal pelagics yield only about 56% of their long-term potential (Table 7-1), and certain species are fished

... SPECIES AND STATUS

near or over maximum production levels. Three of the four mackerel stocks are considered overfished because of previous overexploitation and have been managed under rigid rebuilding schedules since 1983. Atlantic group Spanish mackerel was removed from overfished status in 1993.

The Gulf king mackerel stock is believed to have a large long-term potential, but it is severely depleted. Recent average annual production is at 28% of its maximum level, and major stock reductions were due to excessive harvests from the late 1970's through the early 1980's. Absence of fishing controls and sparse data hampered conservation until 1986.

The Atlantic king mackerel group is near maximum production. The 1992-93 estimated spawning potential ratio (SPR) level is 53% of the maximum level. Spanish mackerel is below maximum production but is recovering. Currently, fishing mortality is less than $F_{30\%SPR}$. Accurate assessment of the status of cobia and dolphin is not yet possible. Atlantic cobia yields have been stable, and fishing mortality is assumed to be low. Gulf cobia is believed to be more heavily exploited, and some indication of significant bycatch mortality exists. Cobia and dolphin are mostly caught by recreational anglers, but data needed to assess long-term production are limited. In addition, information is needed to investigate the possibility of separating cobia stocks into Gulf of Mexico and Atlantic groups.

Figure 7-1.—Atlantic coast migratory pelagic fish landings and abundance (biomass) indices for king and Spanish mackerels, 1979-91.

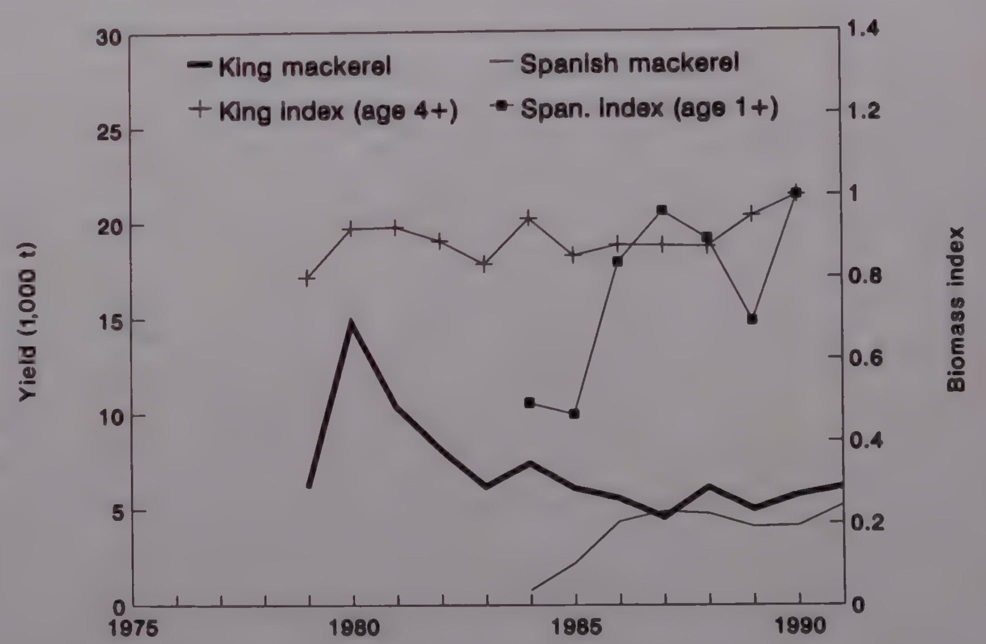


Table 7-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic coastal migratory pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) = 28,069 t
Current potential yield (CPY) = 20,093 t
Recent average yield (RAY)[1] = 15,887 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Dolphin	4,430	Unknown	Unknown	Unknown	Unknown
King mackerel					
Gulf of Mexico	2,825	2,024	9,750	Over	Below
Atlantic	2,828	5,581	3,632	Under	Above
Spanish mackerel					
Gulf of Mexico	2,007	3,956	5,535	Over	Near
Atlantic	2,641	2,946	3,702	Full	Near
Cobia	1,134	Unknown	998	Unknown	Unknown
Cero	22	Unknown	Unknown	Unknown	Unknown

[1]1989-92 average.

ISSUES

Transboundary Stocks and Jurisdiction

Coastal pelagic species will continue to require the coordination of Federal, state, and international regulatory actions to effectively manage stocks throughout their migratory range. In the future, determination of the status of the western Gulf of Mexico resources will require an increase in the information base of Mexican catches and their associated biological data.

Allocation

Allocation of the yield between recreational and commercial users remains an important issue. Future allocation decisions will require an increase in the precision and accuracy of user-specific harvest levels and in the understanding of the spatial segregation of the resource.

INTRODUCTION

"Reef fish" include more than 100 species (Table 8-1) that prefer coral reefs, artificial structures, or other hard bottom areas, and tilefishes that prefer muddy bottom areas. They range along the coast to a depth of about 200 m, from Cape Hatteras through the Gulf of Mexico and through the Caribbean, depending on the species and region. Reef fisheries are extremely complex, have many users (commercial, artisanal, recreational, and scientific), and vary greatly by location and species. Anglers fish for food, commerce, sport, and trophies. They operate from charterboats, headboats, private boats, and shore while using fish traps, hook and line, longlines, spears, trammel nets, bang sticks, and barrier nets.

Reef fish fisheries are closely associated with fisheries for other reef organisms including spiny lobster, conch, stone crab, corals, and "live" rock and ornamental aquarium species (Unit 11). Nonconsumptive uses of reef resources (e.g. ecotourism, sport diving, education, and scientific research) are also economically important and can conflict with traditional commercial and recreational fisheries. Although reef fish have been caught for centuries, good statistical data for most areas began in the late 1970's when recreational fishery surveys were started. Fishery data

Table 8-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic, Gulf of Mexico, and Caribbean reef fishes. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY)[1] = 48,054 t
Current potential yield (CPY)[1] = 34,677 t
Recent average yield (RAY)[2] = 35,185 t

Area and species	Yield (t) RAY[2]	CPY[1]	LTPY[1]	Status of utilization	Status of stock level
Gulf of Mexico					
Red snapper	2,228	1,800	15,000	Over	Below
Red grouper	3,862	Unknown	Unknown	Full	Near
Nassau grouper and jewfish[3]	73	0	Unknown	Over	Below
Shallow groupers (7 species)	2,222	Unknown	Unknown	Over	Unknown
Other groupers (5 species)	624	Unknown	Unknown	Unknown	Unknown
Other snappers (14 species)	4,222	Unknown	Unknown	Unknown	Unknown
Porgies (6 species)	3,798	Unknown	Unknown	Unknown	Unknown
Amberjacks (2 species)	2,283	Unknown	Unknown	Unknown	Unknown
Grunts (3 species)	1,228	Unknown	Unknown	Unknown	Unknown
Sea basses (3 species)	678	Unknown	Unknown	Unknown	Unknown
Others (16 species)	4,418	Unknown	Unknown	Unknown	Unknown
Atlantic					
Wreckfish	1,100	Unknown	Unknown	Full	Near
Vermilion snapper	550	Unknown	Unknown	Over	Below
Red snapper	195	Unknown	Unknown	Over	Below
Red porgy	346	Unknown	450	Over	Below
Nassau grouper and jewfish[3]	7	0	Unknown	Over	Below
Other groupers (16 species)	1,323	Unknown	Unknown	Over	Below
Sea basses (3 species)	1,040	Unknown	Unknown	Unknown	Unknown
Other snappers (12 species)	708	Unknown	Unknown	Over	Below
Amberjacks (2 species)	887	Unknown	Unknown	Unknown	Unknown
Other porgies (8 species)	844	Unknown	Unknown	Unknown	Unknown
Grunts (11 species)	427	Unknown	Unknown	Unknown	Unknown
Others (12 species)	1,507	Unknown	Unknown	Unknown	Unknown
Caribbean					
Nassau grouper and jewfish[3]	0	0	Unknown	Over	Below
Snappers (10 species)	224	Unknown	Unknown	Unknown	Unknown
Other groupers (6 species)	55	Unknown	Unknown	Unknown	Unknown
Grunts (5 species)	49	Unknown	Unknown	Unknown	Unknown
Others (50 species)	287	Unknown	Unknown	Unknown	Unknown

[1]LTPY is probably greatly understimated and CPY overestimated; although potential production estimates are not available for most species groups, many are probably overutilized.
[2]1989-91 average.
[3]A total fishing prohibition has been imposed or is being considered.

... INTRODUCTION

collection remains difficult because there are diverse users and scattered landings at many ports. Fishing pressure has increased with growing human populations, greater demands for fishery products, and technological improvements, such as longlines, wire fish traps, electronic fish finders, and navigational aids.

Reef fisheries vary widely by area. In most cases, the current and long-term potential yields are unknown, though for many species they are probably higher than present average yields would indicate (Table 8-1). For example, the recent Puerto Rican 3-year average landings for most species were only a small fraction of the highest reported annual landings. In many cases, data are not available by species, fishery component, or area. Statistics are confounded because species are not further identified in the market categories reported (i.e. groupers, snappers, grunts). The reef fish management unit includes about 100 species (excluding those for the marine aquarium trade). In the southeastern U.S. region, the unit is managed by the South Atlantic Fishery Management Council, Gulf of Mexico Fishery Management Council, and the Caribbean Fishery Management Council for the EEZ, and eight states, the U.S. Virgin Islands, and Puerto Rico for territorial waters.

In the Gulf of Mexico, the Reef Fish Fishery Management Plan prohibits the use of fish traps, roller trawls, and powerheads on spearguns within an inshore stressed area; places a 33 cm total length minimum size limit on red snapper; and imposes data reporting requirements. A 20% spawning potential ratio was established as a basis to measure overfishing. Presently there is a 7-fish recreational bag limit and a 1,390 t commercial quota for red snapper. For grouper, a 5-fish recreational bag limit and 4,455 t shallow-water and 727 t deep-water commercial quotas were established. Other regulations included a ban on the harvest of jewfish, a framework procedure for establishing TAC's and allowing the target date for rebuilding to be changed depending on scientific information, and a revised target year of 2009 for rebuilding the red snapper stock. In 1992, a moratorium was established for issuing new commercial reef fish permits.

In the southern U.S. Atlantic, the Snapper-Grouper Fishery Management Plan emphasizes minimum size limits, bag limits, and commercial quotas. Seasonal closures exist, and the taking of jewfish or Nassau grouper is prohibited. Various gears are restricted, including a prohibition of roller trawls and fish traps (except sea bass traps). Certain commercial fishing methods are prohibited in designated special management zones around some artificial reefs. An Individual Transferable Quota (ITQ) system has been established for commercial wreckfish fishermen which is based on historic catch. It provides fishermen with a quota that can be taken any time during the season or bartered or sold to another fisherman.

In the U.S. Caribbean, the Fishery Management Plan for the Shallow Water Reef Fish Fishery of Puerto Rico established regulations to rebuild declining reef fish stocks in the EEZ and reduce conflicts among fishermen. It established criteria for the construction of fish traps, required owner identification and marking of gear and boats; prohibited the hauling of or tampering with another person's traps without the owner's written consent; prohibited the use of poisons, drugs, other chemicals, and explosives for the taking of reef fish; and established a minimum size limit on the harvest of yellowtail snapper and Nassau grouper. Additional regulatory amendments have been designed to protect and rebuild the stocks.

SPECIES AND STATUS

More than 100 reef fishes are important to commercial or sport fishermen (Table 8-1). While landings and value for individual species are not large, reef fishes overall produce significant landings and values (Fig. 8-1, 8-2, 8-3). Recent average commercial catches for the U.S. Atlantic and Gulf have been about 20,500 t with a dockside ex-vessel revenue of $48 million. Sport fishermen make more than 20 million angler-trips annually.

Reef fishes are vulnerable to overfishing

... SPECIES AND STATUS

owing to their long lives, slow growth, ease of capture, large body size, delayed reproduction, and other factors. Most are probably either fully utilized or overutilized (Table 8-1). Red snapper, traditionally the most important Gulf reef fish, is overutilized in part as a result of its incidental catch by the shrimp fishery. Eight of the ten major species in the Atlantic headboat fishery show significant size declines since 1972. In the Caribbean, such traditional fishery mainstays as Nassau grouper have practically disappeared, and total landings of species of more recent importance like the red hind have declined since the late 1970's. Landings of amberjack, lane snapper, vermilion snapper, and similar species have increased as catches of traditional species have declined.

Figure 8-1.—Recreational and commercial reef fish landings from the Gulf of Mexico and the index of abundance of young red snappers, 1979-91.

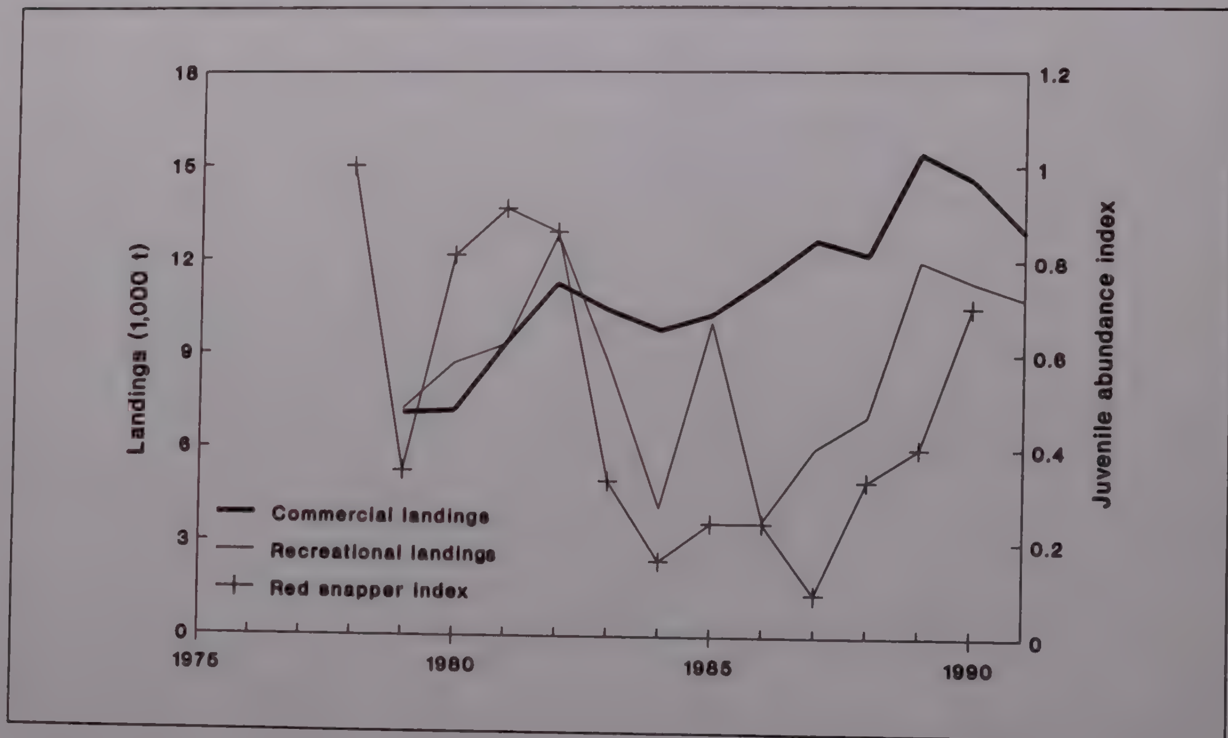
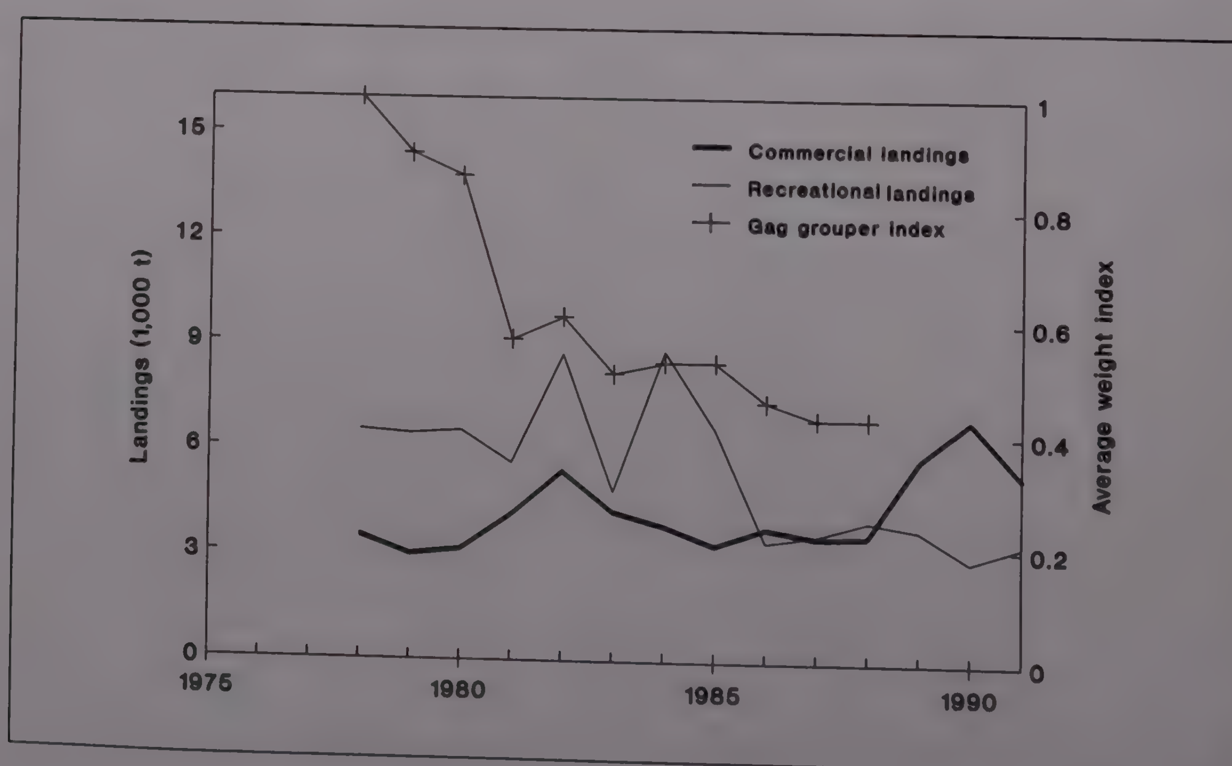


Figure 8-2.—Recreational and commercial reef fish landings from the southeastern U.S. Atlantic coast and the index of abundance (average weight) of gag, 1978-91.



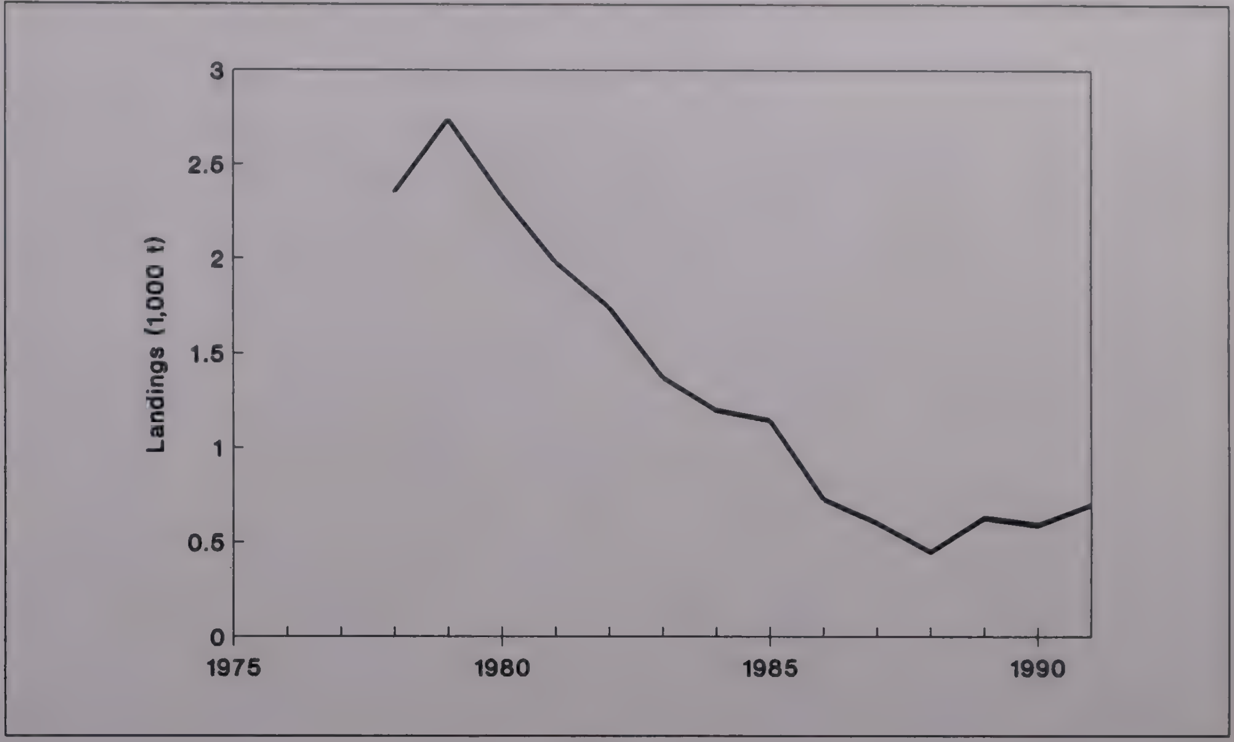


Figure 8-3.—U.S. reef fish landings from Caribbean waters, 1978-91.

ISSUES

Bycatch and Multispecies Interactions

Reef fish form a complex, diverse multispecies system. The long-term harvesting effects on reefs are not well understood, requiring cautious management controls of targeted fisheries as well as bycatch. Removals of apex predators from the reef complex may result in species composition shifts in dominance. Major bycatch issues currently occur with the capture and discarding of red snapper by vessels fishing for shrimp with small-mesh nets. This bycatch problem means that, in order to meet the rebuilding goals for the stock, targeted harvests must be even more tightly restricted. Bycatch of other species may pose similar difficulties as will the capture of undersized fish, even if they are released. The mortality rate of released fish is poorly known.

Scientific Information and Adequacy of Assessments

Several stocks of reef fish are currently depleted and need to be rebuilt (e.g. jewfish, Nassau grouper). A variety of management measures need to be explored, including the use of artificial reefs and the effectiveness of marine parks and reserves to protect spawning areas.

There are a number of important outstanding scientific issues which need to be addressed to improve the advice for management. The long-term potential yield for many of the reef fish species is not known. Data on catch and the identification of species are inadequate for many stocks and needs to be obtained on a routine basis to prepare stock assessment advice. Additional life history and biological data are needed to better understand this complex of species.

Allocation

Reef fish resources are utilized by a wide range of groups. Commercial and recreational fishermen may come into conflict with one another as well as with other users such as ecotourists. Balancing the interests of these groups is an important management issue.

Progress

An individual transferable quota system was implemented for wreckfish in April 1992. Since then, the shares are generally holding their value and fish prices have improved over prior years.

INTRODUCTION

Important species in this unit are the Atlantic croaker, spot, red drum, black drum, kingfishes (whiting), spotted seatrout, and other seatrouts (Table 9-1). The drum family includes several commercially and recreationally important fishes that have been harvested since at least the late 1800's when commercial landings were first estimated. Other fisheries are much more recent. A classic example is the popularity of "blackened redfish" in the 1980's which stimulated a significant demand for red drum so that in a few years the stock was seriously depleted.

Most drum and croaker are harvested in state waters and are therefore under state management. In recent years, several states have set regulations favoring recreational use of some species, such as the red drum.

Pogonias cromis

Commercial adult red drum purse seining in Federal waters of the Gulf of Mexico developed rapidly in the middle 1980's as demand grew for "blackened redfish." Before that, nearly all red drum were harvested in nearshore state waters as juveniles. But as the offshore fishery developed, it became clear that the schooling adult redfish were extremely vulnerable to heavy harvests. Analyses showed that long-term potential yields for this fishery required limiting the harvest of the larger adult fish. In addition, greater inshore redfish catches by recreational and commercial fishermen, complicated by other factors, had cut the number of young fish that could have replenished offshore adult stocks.

Eventually a Red Drum Fishery Management Plan was developed for Gulf and, later, Atlantic waters. Both plans ban red drum fishing in Federal waters until the adult population increases in size. This effectively bars a significant adult red drum fishery in Federal waters as long as state rules favor substantial inshore fishing for young red drum. State actions so far have preserved inshore harvests and allocated most or all of the catch to sport fishermen.

Table 9-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of drum, croaker, and related species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY)[1] =	75,815 t
Current potential yield (CPY)[1] =	25,689 t
Recent average yield (RAY)[2] =	25,689 t

Species and area	Yield (t) RAY[2]	CPY[1]	LTPY[1]	Status of utilization	Status of stock level
Black drum	6,128	Unknown	Unknown	Unknown	Unknown
Atlantic croaker	4,946	Unknown	50,000	Over	Below
Spot	3,336	Unknown	Unknown	Unknown	Unknown
Red drum					
Gulf of Mexico	2,828	2,828	7,900	Over	Below
Atlantic	507	Unknown	Unknown	Over	Below
Seatrouts	6,250	Unknown	Unknown	Unknown	Unknown
Kingfishes (whiting)	1,694	Unknown	Unknown	Unknown	Unknown

[1]LTPY is probably underestimated and CPY overestimated; although potential production estimates are not available for some species groups, it is expected that they may be overutilized.
[2]1988-90 average.

SPECIES AND STATUS

Commercial drum landings peaked in 1956 at over 32,000 t, more than 20,000 t above the 1953 level. That great increase was stimulated by development of raw material sources for the pet food industry from the northern Gulf of Mexico. Atlantic croaker was sought for pet food as well, and about 76% of the associated landings were croaker and sand and silver seatrout. This pet food catch was reported with the "industrial fishery" data after 1956, and estimates of its size and value have since been unavailable. Status and potential yields for these species are given in Table 9-1.

The ex-vessel revenue from this group for human consumption was about $10 million in 1978. This increased to about $22 million in 1986, largely as a result of an increase in the price of the fish.

The overall sport catch of these species has been about equal to the commercial harvest for human consumption (Fig. 9-1).

ISSUES

Bycatch and Multispecies Interactions

Efficient and economical means of reducing the bycatch of finfish in the shrimp fishery must be developed. Large numbers of Atlantic croaker, spot, and seatrout (sand, silver, spotted, etc.) are caught and killed in shrimp trawls. Estimates of the 1972-89 bycatch in the Gulf's offshore shrimp fishery averaged about 500 million spot, 1 billion seatrout, and 7.5 billion croaker. These species constitute the bulk of the offshore bycatch of finfish which averaged about 175,000 t during the 1980's.

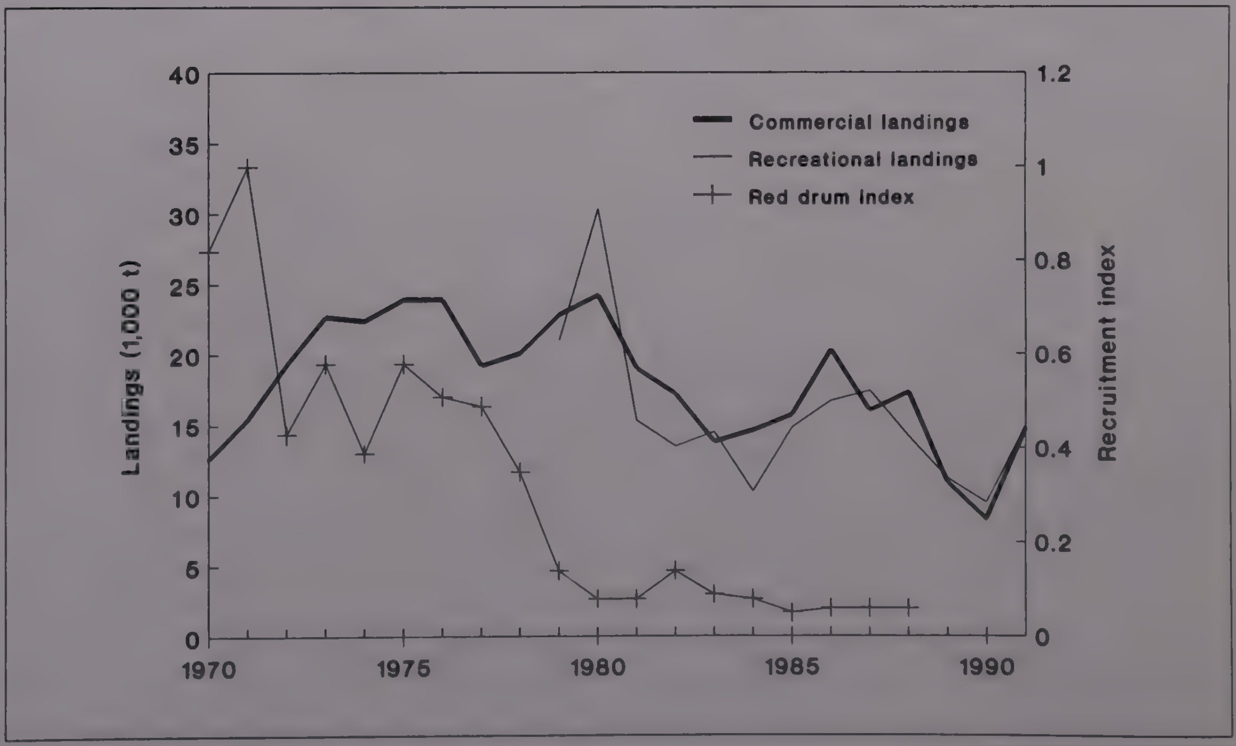


Figure 9-1.—U.S. drum and groundfish landings from southeastern U.S. coastal waters and the red drum recruitment index for the Gulf of Mexico, 1970-91.

INTRODUCTION

Menhaden are a herring-like species found in coastal and estuarine waters of the U.S. Atlantic and Gulf of Mexico. They form large schools at the surface which are located by aircraft and harvested to produce fish meal, oil, and soluble proteins. The fishery is vertically integrated, generally with company-owned vessels, spotter aircraft, and processing plants. An active baitfish fishery along the Atlantic and Gulf coasts harvests about 5% of the amount landed by the industrial fishery. These fisheries are managed by individual states, with intrastate coordination handled through the Atlantic States Marine Fisheries Commission and the Gulf States Marine Fisheries Commission (GSMFC). Menhaden are prey for many fishes and sea birds.

In the Gulf of Mexico, Gulf butterfish have been a component of the catch in the industrial bottomfish and shrimp fisheries, and were either discarded or processed for pet food or fish meal. In 1986, a directed bottom trawl fishery for Gulf butterfish started with the arrival of New England freezer trawlers. The New England vessels fished in the Gulf of Mexico during the springs of 1986 and 1987, the spring and summer of 1988, and briefly during the spring of 1988. In 1987, several vessels experimented with fishing for Gulf butterfish. These early trips led to major refits of a number of shrimp trawlers and one purse seiner in 1988. At one point in 1988, 15 vessels were engaged in the directed fishery for butterfish. The market for Gulf butterfish was saturated early during the summer of 1988. As a result, the New England vessels returned north, and most of the Gulf vessels switched back to shrimping. The directed fishery for Gulf butterfish continued in 1989, 1990, and 1991, with one or two Gulf vessels targeting butterfish. Gulf butterfish are assessed as a single stock, and the fishery is not regulated.

SPECIES AND STATUS

Menhaden are specific to the Atlantic and Gulf of Mexico. In the U.S. Atlantic, the resource is fully utilized with a long-term potential yield of 480,000 t per year and a recent average yield of 360,000 t per year. In the Gulf of Mexico, the menhaden resource is fully utilized with a long-term potential yield of 660,000 t and a recent average yield of 500,000 t. Gulf butterfish is underutilized with a long-term potential yield of 26,500 t and a recent average yield of 19,700 t.

Atlantic Menhaden

Atlantic menhaden are found from Nova Scotia, Can., to West Palm Beach, Fla. As coastal waters warm in April and May, large surface schools form along the coasts of Florida, Georgia, and the Carolinas. The schools move slowly northward, stratifying by age and size during the summer, with the older and larger fish generally moving farther north. The southward migration begins in early fall with surface schools disappearing in late December or early January off the Carolinas. Atlantic menhaden may live 10 years, but most fish caught are 3 years of age or younger.

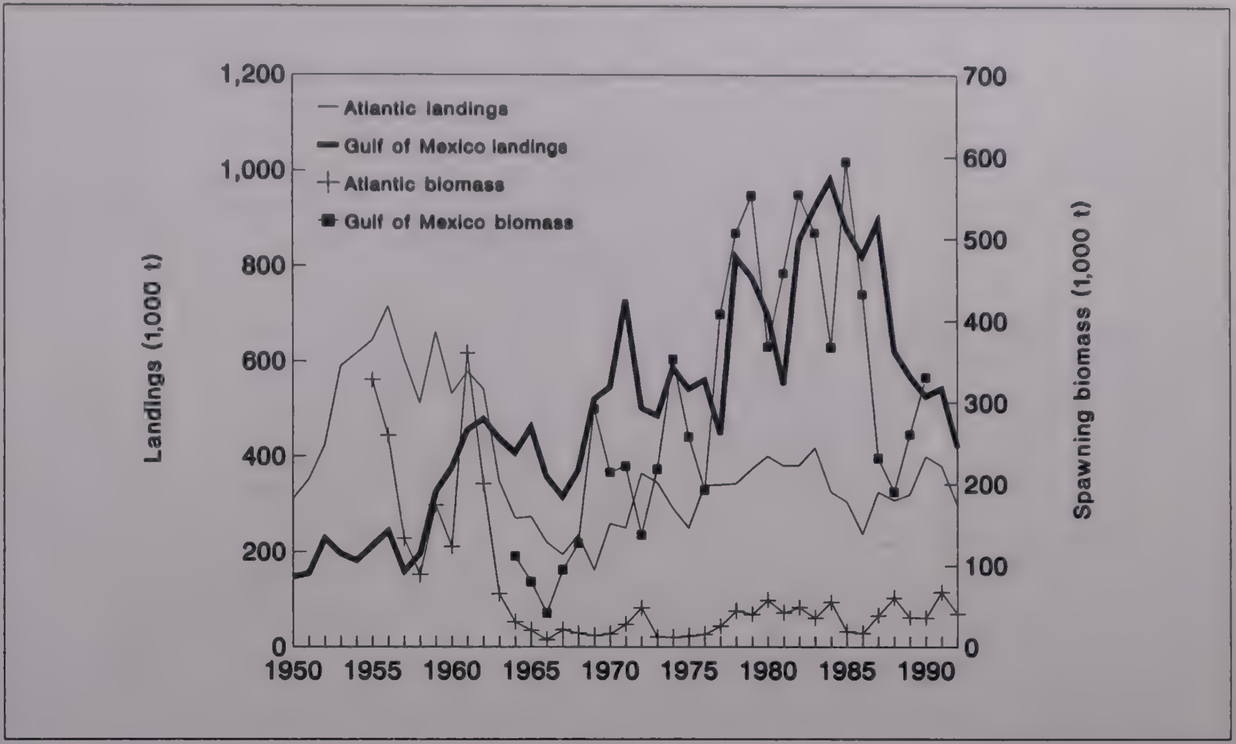
Atlantic menhaden
Brevoortia tyrannus

Menhaden landings rose during the 1940's and early 1950's, peaking at 712,100 t in 1956. Landings remained high during the late 1950's and early 1960's, dropped precipitously during the middle 1960's, and remained low, bottoming out at 161,600 t in 1969 (Fig. 10-1). Since 1970, landings have improved but not to the levels of the late 1950's. A recent peak of 418,600 t occurred in 1983, even though recruitment to age 1 is comparable with the 1950's. The commercial ex-vessel revenue of Atlantic menhaden for 1987-91 averaged $34.9 million per year.

In 1992, several menhaden reduction or processing plants were in operation, located in Beaufort, N.C.; Reedville, Va.; coastal Maine (three Russian factory ships as part of two internal-waters processing agreements); and New Brunswick and Nova Scotia, Can.

The stock collapse in the 1960's drove fishing effort southward to North Carolina and Virginia where menhaden are

Figure 10-1.—U.S. menhaden landings and spawning biomass from the Gulf of Mexico and southeastern Atlantic coast, 1950-92.



... Atlantic Menhaden

generally younger and smaller than those in the north. Overutilization owing to "growth overfishing" (catching too many fish before they grow to full size) has been a prime management concern for this stock. While maximum spawning potential estimates have been low (10%), estimates of spawning stock biomass have rebounded from the very low levels of 1965-75, although not to the very high level of the late 1950's. A new management plan was adopted by the ASMFC in September 1992 which provided for an annual review of six "trigger" variables (landings in weight, percentage of age 0 and adults in numbers in the landings, recruits to age 1, spawning stock biomass, and maximum spawning potential). Exceeding prespecified levels of trigger variables in conjunction with ancillary information will determine the need for specific management actions.

Gulf Menhaden

Gulf menhaden are found from Mexico's Yucatan Peninsula to Tampa Bay, Fla. They form large surface schools that appear in the nearshore Gulf waters from April to November. Although no extensive coastwide migrations are known, some evidence suggests that older fish move toward the Mississippi River Delta. Gulf menhaden may live to age 5, but most of those landed are ages 1 and 2. In 1992, active Gulf menhaden reduction plants were located in Moss Point, Miss., and in Empire, Dulac, Morgan City, Intracoastal City, and Cameron, La.

Historically, landings rose from the fishery beginning after World War II to a peak of 982,800 t in 1984 (Fig. 10-1). Landings were generally high during the middle 1980's (greater than 800,000 t for 1982-87), but they declined steeply from 894,200 t to 421,400 t between 1987 and 1992. During this period (1987-92), the number of processing plants declined from eight to six, and vessels from 75 to 51. Although landings or catch per unit of effort (CPUE) showed a similar decline (1.48 t/vtw in 1987 to 1.03 t/vtw in 1992 (vtw is vessel-ton-weeks), CPUE is not useful as an index of population abundance for menhaden. The commercial ex-vessel revenue of Gulf menhaden for 1987-91 averaged $58.4 million per year.

Because the Gulf stock is short lived and has a high natural mortality, "growth overfishing" has not been a major management concern. Management coordinated through the GSMFC consists of a 6-month fishing season (mid-April through mid-October) and closure of inside waters across the northern Gulf of Mexico. A revision to the fishery management plan was initiated during 1993 (last revised in 1988). In fall 1992, GSMFC recommended changing the Gulf season ending date to 1 November. Coastal states are in the process of acting on that recommendation within their regulatory framework.

Gulf Butterfish

Total catch of Gulf butterfish in 1991 was 19,490 t (Fig. 10-2), about the average annual catch for the 1986-91 period of 19,700 t. Butterfish incidentally captured by the offshore Gulf of Mexico shrimp fleet has composed from 80% to 97% of the total annual catch since 1986. Length composition data indicate that annual catch is dominated by age 1 fish, with few age 0 and age 2+ fish.

The current and long-term potential yields are estimated at 26,500 t for Gulf butterfish. The recent average annual yield is 19,700 t (Table 10-1).

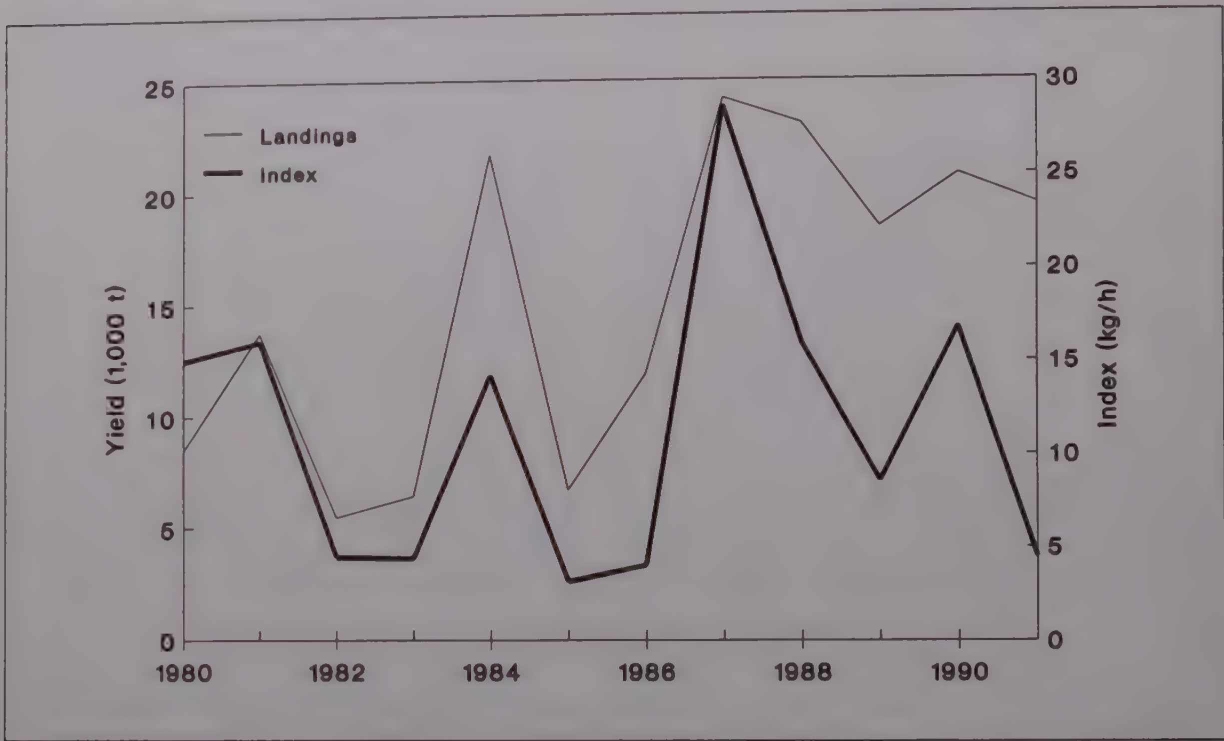


Figure 10-2.—U.S. butterfish landings and index for the Gulf of Mexico, 1980-1991.

Table 10-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of southeastern menhaden and butterfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) =	1,166,500 t
Current potential yield (CPY) =	886,500 t
Recent average yield (RAY)[1] =	879,700 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Menhaden					
Gulf of Mexico	500,000	500,000	660,000	Full	Near
Atlantic	360,000	360,000	480,000	Full	Near
Gulf butterfish	19,700	26,500	26,500	Under	Near

[1]1990-92 average.

ISSUES

Management Concerns

Atlantic menhaden continue to be growth overfished, which reduces the opportunity for greater weight production. Additionally, social concerns have resulted in numerous area closures along the Atlantic coast. Gulf menhaden landings have declined greatly since 1988; however, estimates of maximum spawning potential remain high (about 40%).

Transboundary Stocks and Jurisdiction

Because this resource migrates long distances along the coast, interstate coordination of menhaden management is required for Atlantic menhaden along the U.S. Atlantic coast and for Gulf menhaden along the northern Gulf of Mexico through the marine fisheries commissions. Fish landed at processing plants in New Brunswick and Nova Scotia, Canada, were caught off Maine by U.S. vessels and transported to Canada for processing.

Bycatch and Multispecies Interactions

Two Saltonstall-Kennedy studies funded in 1992 that investigated bycatch of other marine species in the Atlantic and Gulf menhaden purse-seine fisheries show very low bycatch incidence (<0.1% of other species). The importance of menhaden as prey for other species should be considered with respect to multispecies resource management.

The most important issue for Gulf butterfish is determination of the volume incidentally taken in the Gulf of Mexico shrimp trawl fishery.

INTRODUCTION

Important recreational and commercial marine invertebrates in the southeastern United States include shrimp, spiny lobster, stone crab, conch, and coral (Table 11-1). Some fisheries, as for coral, are almost nonexistent. Others, like the penaeid shrimp fishery, are both extensive and extremely valuable: Shrimp are one of the most valuable U.S. fisheries based on ex-vessel revenue. Some fisheries, such as those for spiny lobster and stone crab, have only moderate value on a national basis but are very important regionally. Because of the diversity in species, fisheries, geographic locations, yields, values, etc., each species group in the marine invertebrates must be examined separately for proper perspective.

Penaeid shrimp have been fished commercially since the late 1800's. The first fishery used long seines in shallow water, until the otter trawl, introduced in 1915, extended shrimping to deeper waters. At first, most vessels towed one large trawl, sometimes 120 feet wide at the mouth. Soon, a two-trawl arrangement (each about 40-75 feet wide at the mouth) was found more effective. Some shrimpers are using a twin-trawl system which tows four trawls of about 40 feet wide at the mouth. The twin-trawl system is now very common gear on commercial offshore shrimpers.

Regulations in the Gulf of Mexico shrimp FMP restrict shrimping by closing two shrimping grounds. There is a closure of fishing grounds off Texas for brown shrimp and a closure off Florida for pink shrimp. Also, there are size limits on white shrimp caught in Federal waters and landed in Louisiana. These regulations strive to improve the monetary value of the shrimp fishery.

In the South Atlantic, white shrimp stocks are centered off the Georgia and South Carolina coasts. Brown shrimp are centered off the North and South Carolina coasts. The Atlantic fishery is much smaller than in the Gulf and currently is

Table 11-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of southeast and Caribbean species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	126,656 t
Current potential yield (CPY) =	120,732 t
Recent average yield (RAY)[1] =	121,574 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Shrimp					
Brown					
Gulf of Mexico	63,223	Unknown	62,512[2]	Over	Near
Atlantic	3,638	Unknown	3,782	Over	Near
White					
Gulf of Mexico	32,111	Unknown	34,995[2]	Over	Near
Atlantic	5,243	Unknown	5,243	Over	Near
Pink					
Gulf of Mexico	4,901	Unknown	7,488[2]	Over	Below
Atlantic	1,070	Unknown	1,070	Over	Near
Royal red	179	Unknown	Unknown	Unknown	Unknown
Seabob	3,309	Unknown	Unknown	Unknown	Unknown
Rock	3,347	Unknown	Unknown	Unknown	Unknown
Spiny lobster					
Southeast U.S.[3]	3,099	2,400	3,565	Over	Below
Caribbean	135	Unknown	Unknown	Unknown	Unknown
Stone crab[4]	1,264	1,121	976	Full	Near
Queen conch[5]	55	55	Unknown	Over	Below
Coral[6]	0	0	Unknown	Unknown	Unknown

[1] 1990-92 average.
[2] Long-term potential of brown, white, and pink shrimp based upon last observed 10-year average annual yield (1983-92).
[3] Yields based upon commercial catches; recreational catch is unknown but may be significant.
[4] Yields are in tons of claws; declawed crabs regenerate new claws.
[5] Landings from Puerto Rico. Fishing prohibited in Florida and U.S. Virgin Islands.
[6] Coral harvests prohibited except for a small take allowed for use in aquarium and pharmaceutical industries.

. . . INTRODUCTION

managed under a Federal FMP implemented in November 1993. This FMP provides for compatible state and Federal closures if needed to protect overwintering shrimp stocks.

Spiny lobsters are managed under a joint FMP, coordinated with regulations by the State of Florida. Current regulations specify a 3-inch minimum carapace length, a closed season from 1 April to 5 August, protection of egg-bearing females, closure of some nursery areas, recreational bag limits, and a controversial two-day "sport" season.

Caribbean spiny lobsters are caught primarily by fish traps, lobster traps, and divers. The Caribbean Fishery Management Council's (CFMC) spiny lobster FMP includes the Federal waters of Puerto Rico and the U.S. Virgin Islands. The Federal plan is based on a 3.5-inch minimum carapace length and protection of young egg-bearing lobsters.

The conch fishery targets the queen conch but also takes other species. Most conch are taken by divers, and the resource can be easily depleted. Conch are currently protected in state and Federal waters off Florida and in the territorial waters of the U.S. Virgin Islands. An FMP is being developed for the Federal waters off Puerto Rico and the U.S. Virgin Islands by the CFMC.

Corals are managed as two groups, hard and soft. Because they are generally slow growing and provide critical habitat for many fishes, hard corals are protected except for very small collections taken by permit for research and educational purposes. Regulations are based on the fact that the value of coral as habitat is far more important than their commercial use.

Soft corals include gorgonians and sea fans. Some gorgonians are taken (about 50,000 colonies per year) for the aquarium and pharmaceutical industries. Growth potential for most species is considered limited. Sea fans are completely protected except for research and educational use by permit.

Stone crabs are caught mainly off southern Florida, though some are landed farther north along Florida's west coast. The Gulf of Mexico stone crab FMP, approved in September 1979, generally extended Florida's regulations into the EEZ. These regulations are based on a minimum claw size of 2.75 inches, biodegradable trap panels, protection of egg-bearing females, and closed seasons. Minimum size regulations assure that crabs have reproduced at least once before being caught.

SPECIES AND STATUS

Shrimp

Brown, white, and pink shrimps account for 89% of the total Gulf of Mexico shrimp catch. In 1992 alone, these three important species produced 88,009 t valued at over $367 million in ex-vessel revenue (Fig. 11-1). They are found in all U.S. Gulf waters inside 60 fathoms (fm). Most of the offshore brown shrimp catch is taken at 11-20 fm depths, white shrimp are caught in 5 fm or less, and pink shrimp in 11-15 fm. Brown shrimp are most abundant off the Texas-Louisiana coast, and the greatest concentration of pink shrimp is off southwestern Florida. In the South Atlantic, white and pink shrimp landings are about 20% of their Gulf counterparts, while brown shrimp are less than 10% of the Gulf yield. Current, recent, and long-term potential yields for these species are given in Table 11-1.

Gulf brown and white shrimp catches have increased significantly over the past 34 years. Pink shrimp catches were stable until about 1985; then they declined in recent seasons and are now at an all-time low. The numbers of young shrimp for each species entering the fisheries have generally reflected the level of catch. All commercial shrimp are harvested at maximum levels. The fishery is believed to have more boats and gear than needed (i.e. reducing fishing effort would not significantly reduce the shrimp catch). Reducing the bycatch of the shrimp industry, however, would help protect finfish resources.

The number of young brown shrimp produced per parent has increased significantly, but not in white and pink shrimp. The brown shrimp increase appears related to marsh alterations. Coastal sinking and a sea-level rise in the northwestern Gulf inundates intertidal marshes longer, allowing the shrimp to feed for longer periods within the marsh area. In the Gulf, both factors have also expanded estuarine areas, created more marsh edges, and provided more

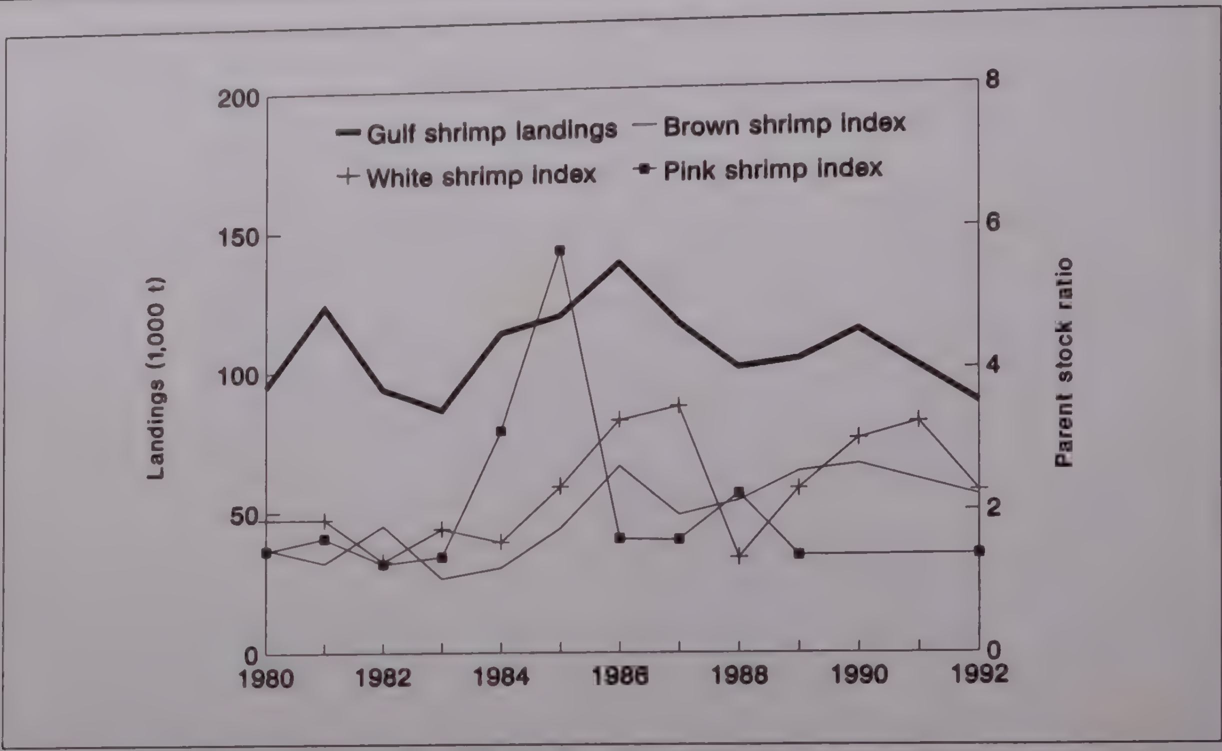


Figure 11-1.—U.S. shrimp landings from the Gulf of Mexico, 1980-92, and the parent stock abundance indices for brown, white, and pink shrimp.

. . . Shrimp

protection from predators. As a result, the nursery function of those marshes has been greatly magnified and brown shrimp production has expanded. However, continued subsidence will lead to marsh deterioration and an ultimate loss of supporting wetlands, and current high fishery yields may not be indefinitely sustainable. Parent stock rates for the three major Gulf species are shown in Figure 11-1.

Spiny Lobster

Annual Florida spiny lobster landings were fairly stable during the 1980's, running about 2,700 t from the Gulf of Mexico, but yielding record landings in 1989 of 3,200 t, with ex-vessel revenue of about $20 million. On Florida's Atlantic coast, landings have averaged 230 t, valued at $2 million. The fishery is considered "overcapitalized," with about 900,000 lobster traps in use. Less than half that number of traps would provide the same catch. Fishermen use live undersized lobster to "seed" traps, but owing to a high mortality rate for these animals, about 30-50% of the potential yield is lost. The recreational fishery is large at the beginning of the season, but its total harvest is unknown. However, the status of these southeast lobster stocks remain below their long-term potential yield.

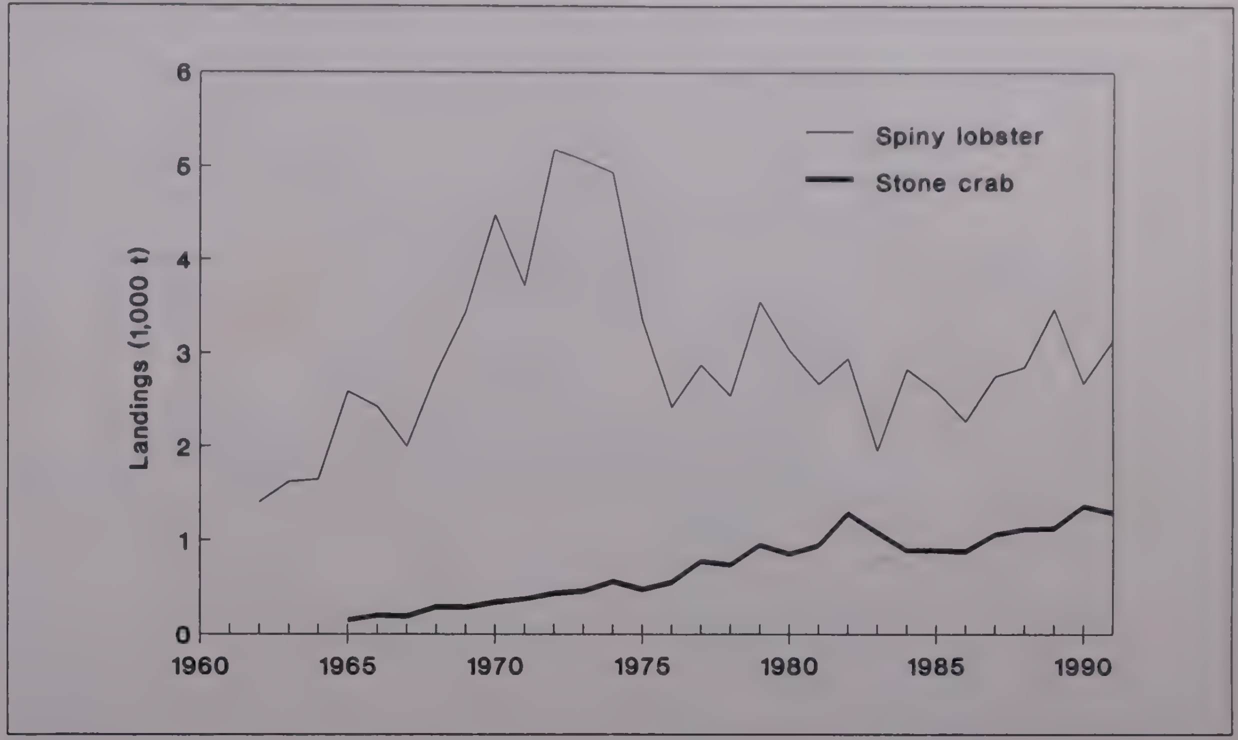
Annual spiny lobster landings for Puerto Rico have averaged 144 t over the past 23 years, varying from 108 t in 1972 to a high of 233 t in 1979, then declining to a low of 65 t in 1988. No precise data are available on fishing effort, but the Puerto Rican stock produced landings of 72 t in 1992 and now appears to be overutilized. U.S. Virgin Islands landings for 1980-88 were fairly stable, averaging 19 t.

Spiny lobster larvae may drift at sea for 9 months, and thus identification of their source or parent stock is almost impossible; however, we need to know far more about their origins and movements to improve our management of them.

Stone Crab

Annual catches of stone crab (claw weight) varied from 1,200 to 1,400 t in the Gulf of Mexico through the 1980's. Recent annual ex-vessel revenue averages $12-15 million. Atlantic coast landings average around 34 t, worth $120,000 in ex-vessel revenue. The number of crab traps set increased from 295,000 in 1979-80 to 567,000 in 1984-85 but have been relatively stable in recent years, though estimated seasonal trap hauls (fishing effort) increased from 3.6 million in 1985 to 4.8 million in 1987. Thus, more of the total landings were harvested earlier, and this shortened the effective length of the fishing season. It is unlikely, however, that recent maximum production figures can be sustained on a long-term basis.

Figure 11-2.—Landings from the southeastern U.S. coastal waters of spiny lobster, 1961-91, and stone crab, 1965-91.



ISSUES

Habitat Concerns

Estuarine and marsh loss remove critical habitat for young shrimp. Additional studies are needed to further assess the impacts of human-induced changes in quantities of habitat, environmental conditions, predator abundance, and pollution in the nursery areas. Florida spiny lobsters depend on reef habitat and shallow-water algal flats for feeding and reproduction. These habitat requirements may conflict with expanding coastal developments. The productivity of stone crabs in Florida Bay is related to water quality and flow through the Everglades. Specific water requirements need to be identified and maintained through comprehensive Everglades water management. A unified program to integrate and study the effects of environmental alterations, fishing technology, regulations, and economic factors on shrimp, lobster, and crab production and restoration is needed, particularly in the reef habitats of south Florida. Steps need to be taken to mitigate or restore lost estuarine habitats.

Transboundary Stocks and Jurisdiction

Spiny lobster stocks in Florida could be of Caribbean origin and swept into the region by currents of the Gulf Stream. Another hypothesis is that they could comprise a number of different spawning stocks. The actual sources of all Florida and Caribbean lobster stocks (both U.S. and foreign) need to be identified and international management established to prevent overharvesting.

Management Concerns

Many small spiny lobsters are caught in the Puerto Rican fishery. If these lobsters were allowed to grow to a larger size before harvest, there would be a substantial increase in yield by weight. Modification of the traps to allow more of the small lobsters to escape needs to be investigated. Small lobsters are sometimes used to bait traps in the lobster fishery. This current practice is wasteful and hinders rebuilding the stock.

A gear conflict between stone crab trappers and shrimp trawlers off southwestern Florida has been mostly resolved in the EEZ with a line separating the fishing areas and seasonal area closures. This approach requires continued monitoring to gauge its success and prevent renewal of conflicts.

The shrimp fisheries are currently overcapitalized, with more fishing effort being expended than needed to harvest the resource. In addition, the harvesting of small shrimp inshore is sacrificing yield and value of the catch by cutting short future growth.

Bycatch and Multispecies Interactions

Shrimp fisheries use small-mesh nets and can catch nontarget species such as red snappers, croakers, seatrouts, and sea turtles. For finfish, this harvest is often of juveniles and may be a major source of mortality on these young fish. Some fish caught by shrimpers are currently at low stock levels (Unit 9). This bycatch may slow or prevent recovery if not mitigated.

Sea turtles are all listed as endangered or threatened under the ESA. Shrimp vessels have been required to use turtle excluder devices in their nets during certain times of the year since 1988 to avoid capturing sea turtles and thus protect the stocks.

Progress

NMFS and the fishing industry are working together to prepare a research plan to address the problems of finfish bycatch by shrimp fisheries in the Gulf of Mexico and South Atlantic.

INTRODUCTION

Pacific salmon support traditional and important commercial and recreational fisheries in Washington, Oregon, and California. Salmon have been very much an integral part of the culture and heritage of the Pacific Northwest, having been harvested since time immemorial by Native Americans. Pacific salmon are anadromous species. They spawn in streams or lakes and migrate to the ocean where they may travel hundreds of miles offshore. Upon reaching maturity, they return to their home stream to spawn and complete their life cycle.

For the period 1990-92 the average annual commercial salmon catch (7.9 million fish) gave revenues of about $140 million at dockside. Recreational catches are more difficult to value since the recreational experiences associated with their catch cannot be easily measured. If sport-caught fish are valued at a conservative $20 each, the 1990-92 average annual recreational catch of 1.3 million fish would be worth about $26 million.

Management of this resource is complex, involving many stocks that originate from various rivers and several management jurisdictions: The U.S.-Canada Pacific Salmon Commission (PSC), state fishery agencies, Indian management entities, and the Pacific Fishery Management Council (PFMC). Two species (chinook and coho) are managed by the PFMC's fishery management plan (FMP). The other three species (sockeye, pink, and chum) are managed primarily by the PSC and state and tribal fishery agencies.

SPECIES AND STATUS

There are five species of Pacific salmon: Chinook, coho, sockeye, pink, and chum. Salmon runs are inherently highly variable in abundance. Catches have fluctuated widely (Fig. 12-1, 12-2, 12-3), and all five species of salmon are overutilized (Table 12-1). Environmental variables tend to play a large role in salmon survival and abundance. For example, El Niño events of unusual warm ocean conditions devastated chinook and coho salmon survival in 1983-85. There are many competing user groups vying to catch salmon, and strict limitations are required to protect the stocks. Thus, salmon management issues are concentrated on catch allocations among user groups and adequate protection of spawning stocks and of juvenile salmon during their outbound migration from home streams to the ocean.

Figure 12-1.—Recreational and commercial chinook salmon landings (millions of fish) in Oregon, Washington, and California, 1960-92.

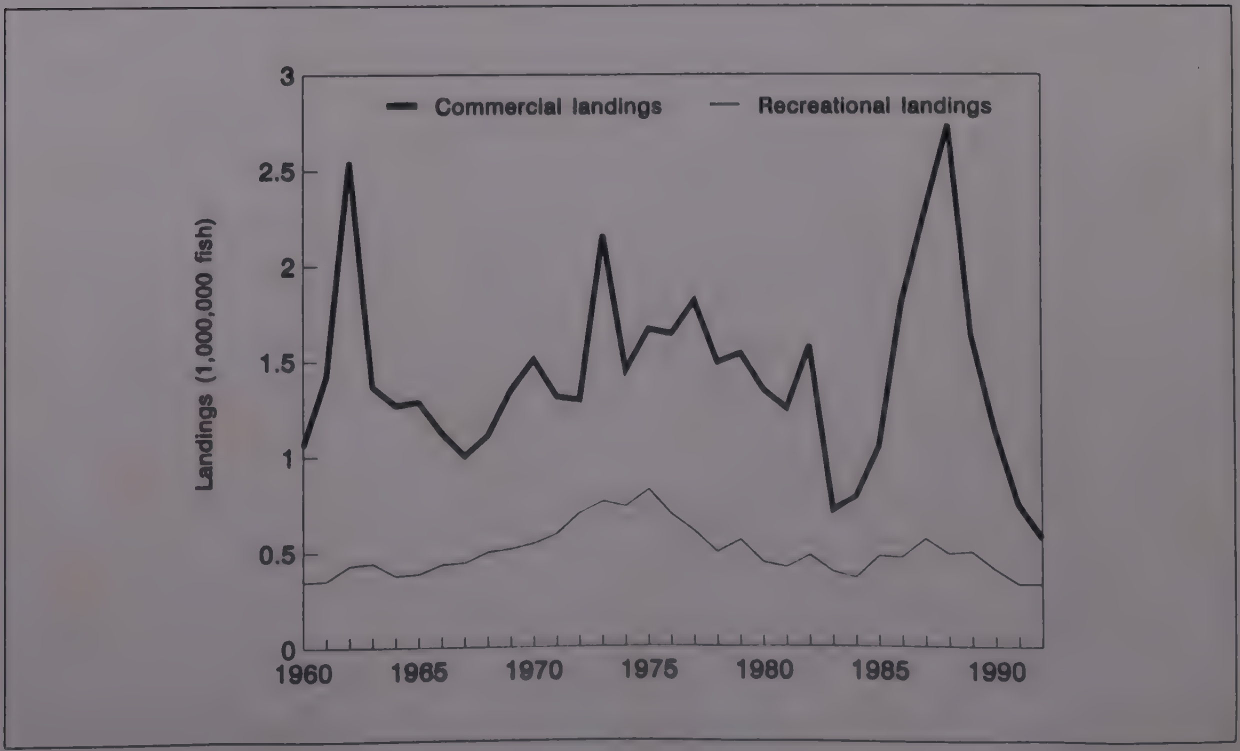


Figure 12-2.—Recreational and commercial coho salmon landings (millions of fish) in Oregon, Washington, and California, 1960-92.

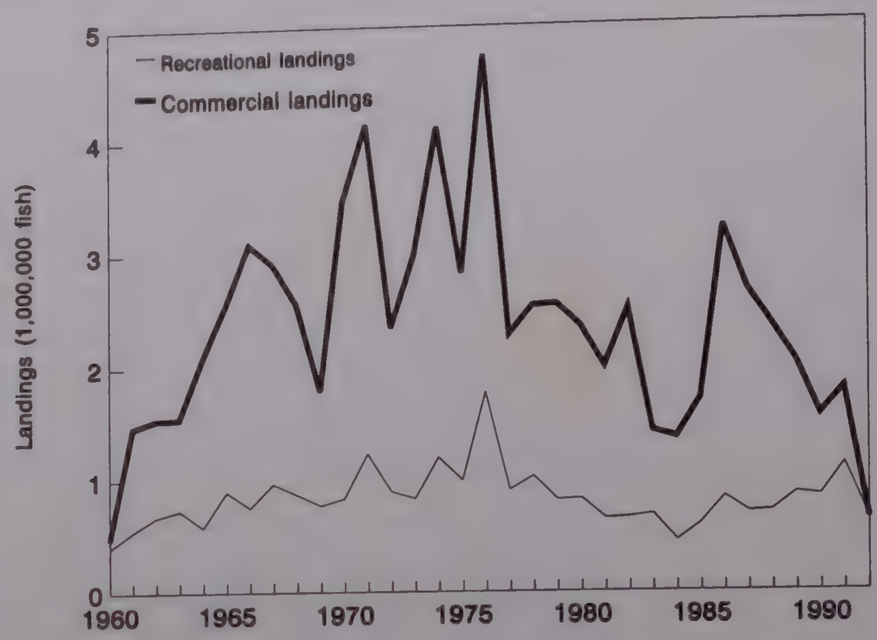


Figure 12-3.—Combined commercial and recreational landings of pink, sockeye, and chum salmon (millions of fish) in Oregon, Washington, and California, 1960-92.

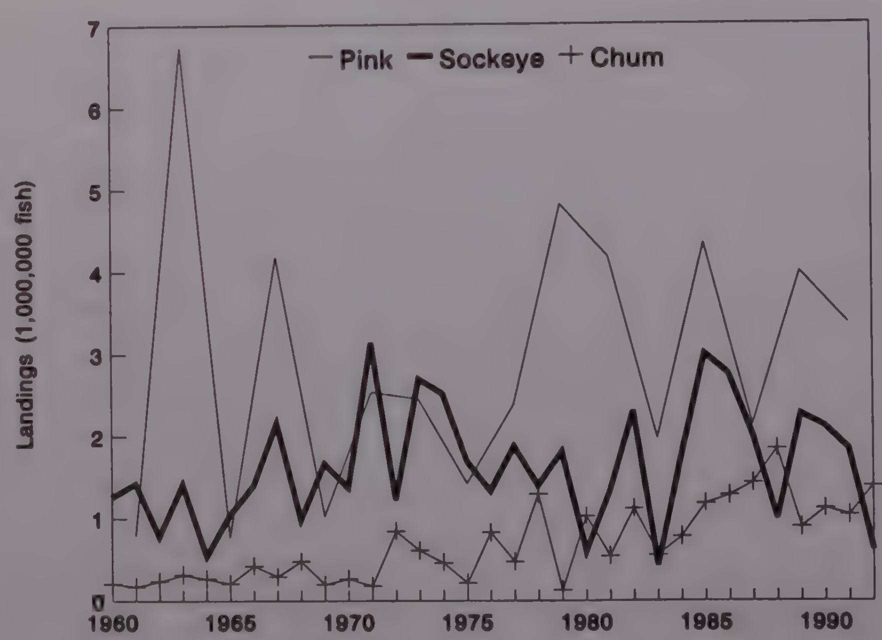


Table 12-1.—Recent average, current potential, and long-term potential yields (in numbers of salmon), and status of utilization and stock levels of salmon in the Pacific coast fishery. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY)[1] = 11,806,000 salmon (43,366 t)
Current potential yield (CPY)[1] = 11,806,000 salmon (43,366 t)
Recent average yield (RAY)[1,2] = 9,085,000 salmon (30,324 t)

	Yield (no. of salmon)			Status of	Status of
Species	RAY[2]	CPY	LTPY[3]	utilization	stock level
Chinook	1,169,000	2,274,000	2,274,000	Over	Below
Coho	2,184,000	3,231,000	3,231,000	Over	Near
Pink	3,191,000	3,496,000	3,496,000	Over	Above
Sockeye	1,524,000	1,788,000	1,788,000	Over	Near
Chum	1,017,000	1,017,000	1,017,000	Over	Near

[1]Conversion from numbers of salmon to an approximate yield in weight may be obtained by using the following estimates for average individual fish weight: Chinook (7.95 kg), coho (3.0 kg), pink (1.85 kg), sockeye (2.09 kg), and chum (5.3 kg).
[2]Average is for 1990-92 except for pink, which is a 1987-89-91 average.
[3]Long-term goals for some stocks include doubling of production, primarily through large-scale improvements in freshwater habitat.

Sockeye, Pink, and Chum Salmon

Pink and chum salmon originate primarily from tributaries of Puget Sound. Chum salmon also originate from some coastal streams extending part way down the Oregon coast. Sockeye salmon originate from a few streams entering Puget Sound and the upper Columbia and Snake Rivers. Some U.S. catches of sockeye and pink salmon are dependent on stocks originating in the Fraser River of Canada. Although recent Fraser River salmon runs have been extremely large, their U.S. catch has been limited under the Pacific Salmon Commission. The average recent annual commercial catches for these species were 1.5 million sockeye salmon (1990-92 average), 3.1 million pink salmon (1987-91 average), and 1.2 million chum salmon (1990-92 average). Their recreational catches, which total 72,000 fish, though important, are minor when compared to recreational catches for chinook and coho salmon. U.S. stocks of pink and chum salmon appear to be fairly stable and are in fairly good condition; however, the Snake River stock of sockeye salmon has been listed as endangered under the Endangered Species Act as of 1991.

Pink salmon
Oncorhynchus gorbuscha

Chinook Salmon

Major producers of chinook salmon are Puget Sound streams in Washington, the Columbia River, the Umpqua and Rogue Rivers in Oregon, and the Klamath and Sacramento Rivers of California. Chinook salmon stocks are labelled as spring, summer, fall, or winter depending on their time of migration from the ocean into fresh water. For the period 1990-92, chinook salmon commercial catches, both natural and hatchery produced, averaged 815,000 fish, while recreational catches averaged 354,000 fish. In recent years, a significant share of the catch has come from hatchery-produced fish. Production of chinook salmon tends to fluctuate widely due to varying escapement and ocean survival. Environmental conditions, such as El Niño events, tend to depress abundance. Some chinook salmon stocks are extremely depressed. The spring/summer and fall chinook salmon runs in the Snake River have been listed as threatened under the ESA; so has the Sacramento River winter-run chinook salmon. NMFS is now considering a petition to list the mid-Columbia River summer chinook salmon under the ESA. Other chinook salmon stocks like the Shasta River run, the Skagit River spring run, the Stillaguamish summer-fall run, the Snohomish summer-fall run, and the Rogue river runs have generally been depressed and have not met escapement goals in recent years.

Coho Salmon

For the period 1990-92, commercial catches of coho salmon averaged 2.18 million fish, while recreational catches averaged 864,000 fish. To an even greater extent than with chinook salmon, hatchery-produced coho salmon have become an increasingly important part of the catch, and in some areas, comprise over 80% of the catch. Coho salmon landings from the ocean fisheries peaked at over 5 million fish in 1976 and then declined rather drastically to around 1 million or less in recent years. This is in large part due to a shifting of most of the allowable catch from the ocean fisheries to inside fisheries, particularly north of Cape Falcon, Oregon. The shift mainly resulted from Federal Judge George Boldt's decision in 1974 to entitle Tribal fishermen up to 50% of the catch of returning salmon that migrated through their usual and accustomed tribal fishing areas.

The NMFS was petitioned to list lower Columbia River natural coho salmon as endangered under the ESA. The release of hatchery-reared fish, degradation of salmon habitat, and overharvesting affected the wild population to such an extent that NMFS determined it did not represent a distinct population segment under the ESA. Consequently, the NMFS did not list the lower Columbia River coho salmon run.

... Coho Salmon

Other coho salmon stocks have been at low levels of production in recent years and have generally been the constraining stocks under stock management. In particular, these are the Queets River stock on the Washington coast and the Hood Canal and Skagit River stocks in Puget Sound. In addition, the Stillaguamish coho stock and the Oregon coastal natural coho salmon stock have failed to meet their escapement goals in recent years. Recently, NMFS has been petitioned to list all Washington, Oregon, and California populations of coho salmon under the ESA.

ISSUES

Habitat Concerns

Worsening freshwater (spawning) habitat has been a significant cause of the salmon decline. This includes siltation problems and, particularly, the lack of water for spawning and fish passage. For example, serious fish passage problems at Columbia River hydroelectric dams have been a major factor in further declines. In California, the conflict is primarily between fish needs for water and farm irrigation demands.

Owing to habitat losses, some salmon runs have already been listed as threatened or endangered under the ESA. These actions have profound implications for severely restricting salmon catches.

Wild vs. Hatchery Stocks

Increased production by salmon hatcheries, particularly of chinook and coho salmon, has raised concerns about the relationship between natural (wild) and hatchery-produced fish. Though hatchery fish supplement natural runs, they also compete with or even replace wild salmon. This potential problem has yet to be adequately addressed from a scientific and management point of view. To this end, NMFS has drafted an interim policy on how it will consider artificial propagation in the listing and recovery of Pacific salmon under the ESA. This policy provides guidelines to assist in the conservation of listed species and to help avoid additional species listings.

Transboundary Stocks and Jurisdiction

Salmon migrate over great distances where they can be intercepted by many fishermen from different nations. The problem of allocation and interception is compounded by dwindling stocks. The problems are addressed as they arise by the affected jurisdictions, but satisfactory solutions have not been easy to define. For example, the Pacific Salmon Commission has been set up to address the allocation of catch between the United States and Canada. Conflicts between treaty Indian and non-Indian fishermen continue to arise and have often been addressed by the Courts. In Washington state, a Federal court ruling that salmon must be managed to protect the smallest or the weakest stock has further curtailed ocean catches in recent years.

Bycatch and Multispecies Interactions

Some salmon, mainly chinook, are incidentally caught at sea in the Pacific whiting fishery (Unit 15). Though the numbers taken are small compared with catches in target salmon fisheries, this incidental catch is a politically sensitive issue when target salmon fisheries continue to be severely restricted.

Progress

For the stocks that have been listed as threatened or endangered under the ESA, recovery plans are being drafted for approval by NMFS in cooperation with various management and user groups. In addition, the Northwest Power Planning Council has developed a strategic plan for salmon restoration and management in northwest rivers. The plan incorporates the interests of a wide range of groups within the region and may go a long way towards improving the status of salmon resources. NMFS is actively engaged with the Department of Interior, EPA, and the State of California (among others) in the implementation of the Central Valley Project Improvement Act. One of the major objectives of this act is to double the anadromous fisheries populations throughout central and northern California during the next decade.

INTRODUCTION

Pacific salmon have long been harvested off Alaska. Today, salmon fisheries provide the state's largest nongovernmental source of employment. They also provide important recreational opportunities and are an integral part of Alaska's native culture and heritage.

Alaska salmon catches have been highly variable (Fig. 13-1). The all-time peak catch of 189 million fish was taken in 1991. Sport harvest of salmon totaled about 909,000 fish in all waters in 1990.

The value of the 1992 statewide catch (314,200 t) has been estimated at $575 million, slightly higher than the $540 million ex-vessel value of the 1990 harvest.

Alaska's 34,000-mile coast is nearly two-thirds the length of the coastline of the "lower 48" states. Salmon management in such a vast area requires a complex mixture of domestic and international bodies, treaties, regulations, and agreements. Federal and state agencies participate in their management. The Alaska Department of Fish and Game (ADFG) manages all fisheries in state waters. Management in the EEZ (3-200 miles offshore) is the responsibility of the NMFS and the NPFMC. Salmon management is also negotiated with Canada through the Pacific Salmon Commission. On a broader international scope, the management of salmon harvest in the high seas of the North Pacific Ocean was authorized by the International North Pacific Fisheries Commission (INPFC) from 1957 to 1992, and via bilateral and multilateral talks and negotiations with Taiwan and the Republic of Korea. In 1993, the North Pacific Anadromous Fish Commission (NPAFC) was formed to replace INPFC. This Commission of four countries (Canada, Japan, the Russian Federation, and the United States) will embark on a new era of salmon management in the North Pacific Ocean. The NPAFC Convention clearly prohibits high seas salmon fishing and trafficking of illegally caught salmon. Coupled with United Nations General Assembly (UNGA) Resolution 46/215, which bans large-scale pelagic driftnet fishing in the world's oceans, salmon harvesting in the high seas should cease, and effective management control can return to the salmon-producing nations.

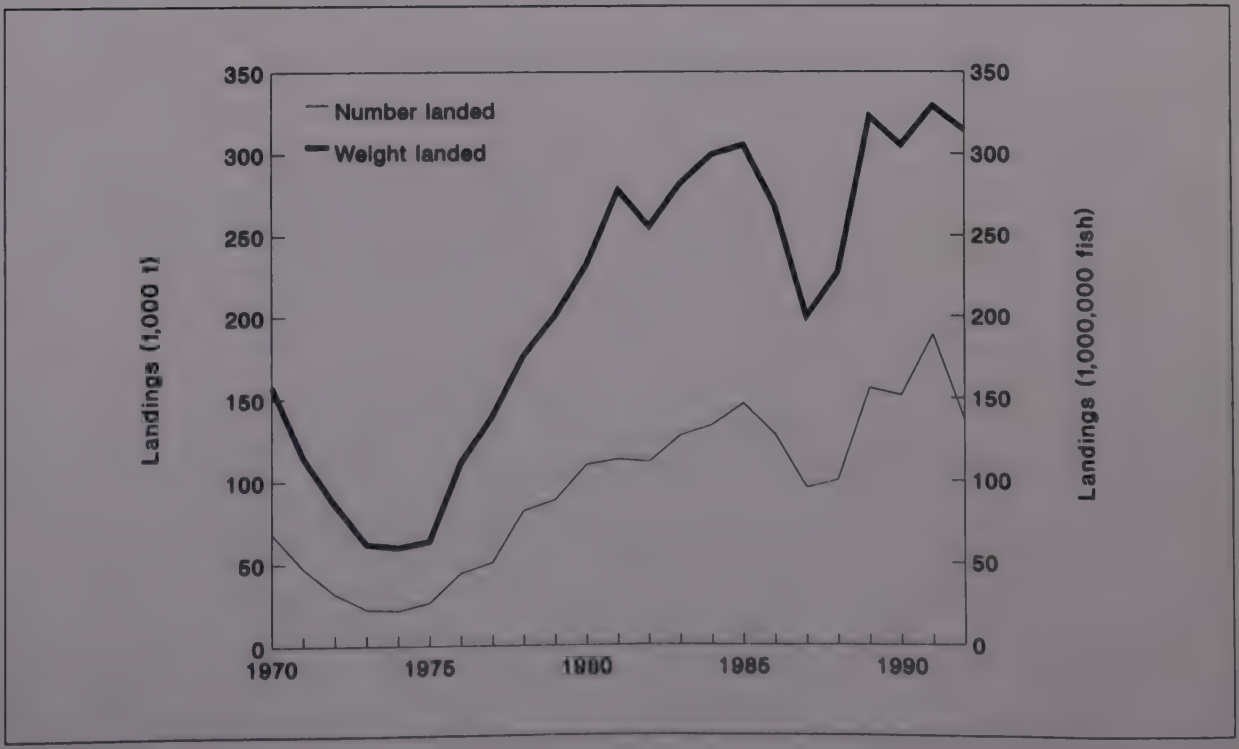


Figure 13-1.—Alaska salmon landings, 1970-92.

SPECIES AND STATUS

Pacific salmon are anadromous species that spend a portion of their life (1-7 years) at sea and return to freshwater streams to spawn and die. From their freshwater spawning grounds, the young salmon may migrate thousands of miles out to sea outside of the U.S. Exclusive Economic Zone (EEZ) before returning to spawn.

Alaska's five salmon species (chinook, coho, chum, sockeye, and pink) are fully utilized, and stocks generally have rebuilt to or beyond previous high levels (Table 13-1). Research has been extensive into all aspects of the salmon life history, and the information has been used to regulate escapement size and catch numbers by season and area.

Some salmon stocks may be locally overutilized. In Bristol Bay, chinook catches in 1990 and 1991 were far below the recent 20-year average harvest of 117,000 fish at 28% and 31% levels respectively. In the lower Yukon River area, chinook catches are about 21% below par. Meanwhile even-year pink salmon in Bristol Bay are far below 1970-90 harvests, and wild sockeye, pink, and chum salmon in Prince William Sound have declined.

Oncorhynchus kisutch

Table 13-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Alaska salmon. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 282,200 t
Current potential yield (CPY) = 282,200 t
Recent average yield (RAY)[1] = 321,500 t

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Pink	127,300	113,200	113,200	Full	Above
Sockeye	139,900	109,000	109,000	Full	Above
Chum	31,700	38,200	38,200	Full	Near
Coho	17,800	16,100	16,100	Full	Near
Chinook	4,800	5,700	5,700	Full	Below

[1] 1990-92 average.

ISSUES

Two important problems facing Alaska salmon are: 1) Interceptions and incidental catch of salmon by other fisheries; and 2) degradation of spawning and rearing habitats.

Bycatch and Multispecies Interactions

Interceptions of Alaska's salmon resources in the high seas of the North Pacific Ocean used to be a serious problem. Two types of high seas driftnet fisheries impacted Alaska's salmon resources: A legal fishery by Japan that was authorized by the INPFC Treaty from 1957 to 1992 and an illegal fishery by squid-driftnetters from different countries. Both fisheries have now been terminated, the former as a result of the new NPAFC Convention and the other due to UNGA Resolution 46/215. A remaining problem of salmon interception by other target fisheries is chinook and chum salmon bycatch by U.S. groundfish fisheries in the Bering Sea and the Gulf of Alaska. About 36,000 chinook salmon were taken incidentally in the trawl fishery in each area in 1991. That same year, about 32,000 chum salmon were estimated in the Bering Sea bycatch and about 12,000 chum in the Gulf of Alaska bycatch. The problem is being addressed by the North Pacific Fishery Management Council through time-area closures and bycatch limits set for the groundfish fisheries.

Habitat Degradation

Logging, mining, and industrial and urban development can often degrade salmon habitat. Though large areas of Alaska's wetlands are presently undisturbed and pristine, providing critical salmon habitat, logging activities have affected about 100,000 acres of stream-side habitat and 3,000 miles of streams. From 1981 to 1988, development was allowed on about 41,000 acres of wetlands. The State of Alaska is exempt from many provisions of the Environmental Protection Agency policy on wetlands development under the President's 1991 Plan for Protecting Wetlands, which allows Alaska to minimize development impacts. Very little information is available on the value of Alaska's vast wetlands as fish habitat.

Progress

Significant progress has been made to control the interception and incidental take of Alaska's salmon resources. First, a formerly legal high-seas salmon fishery by Japan, which was authorized by an international Convention from 1957-1992, was terminated under a new Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean. Second, high seas driftnet fisheries for squid by various countries that also intercept U.S.-origin salmon stocks in the central North Pacific Ocean have been terminated by United Nations General Assembly Resolution 46/215. A remaining problem of salmon bycatch in U.S. groundfish fisheries in the Bering Sea and the Gulf of Alaska is actively being managed by the North Pacific Fishery Management Council through time-area closures and bycatch limits set for the groundfish fisheries.

INTRODUCTION

Several stocks of small pelagic fish along the Pacific and Alaska coasts provide important sources of food, bait, and industrial fishery products. Major stocks include northern anchovy, Pacific sardine, jack and chub (Pacific) mackerel, and Pacific herring (Table 14-1).

The U.S. anchovy fishery is managed under the Northern Anchovy Fishery Management Plan (FMP), while Pacific sardine, jack mackerel, and chub mackerel are managed by the State of California. Jack mackerel north of lat. 39°N are managed under the Pacific Coast Groundfish FMP. All four species are harvested by purse seiners off California and Baja California.

During the 1930's and early 1940's, Pacific sardine supported the largest fishery in the western hemisphere (25% of all fish landed in the United States). Sardine abundance and catches declined after World War II, and the stock finally collapsed in the early 1960's, bringing about a complete moratorium on the fishery beginning in the 1967-68 season. The sardine stock has recently begun to show signs of improvement (Table 14-1), and a small fishery for them has been allowed since 1986.

In 1946, U.S. processors began to can anchovies in quantity, as a substitute for the failing sardine fishery. Anchovy canning declined in the late 1950's. In 1965, due to an increase in anchovy biomass, the California Fish and Game Commission authorized a 75,000 t harvest solely for reduction purposes (conversion to meal, oil, and soluble protein).

The southern California jack mackerel stock has been fished since the late 1940's, when it was used as a market substitute for the dwindling sardine stocks. Jack mackerel are utilized by the fishery in about the same manner as chub mackerel, but they are harder to catch, less valuable, and delivered in smaller quantities. Recently, there has been some interest in developing an offshore fishery for this underutilized resource.

Chub (or Pacific) mackerel supports one of California's more important fisheries and has been the mainstay of the purse seine fleet in recent years. The fishery started in the late 1920's, rose to its peak in 1935, declined in 1953, and in 1967 hit an all-time low. Strong year classes appeared in the late 1970's, and abundance increased dramatically after 1977. But abundance is now thought to be declining. Chub mackerel are harvested by commercial fisheries in California and Mexico and sold fresh, canned for human consumption and pet food, and also is reduced to fish meal and oil.

Pacific herring are fished in all Pacific Coast States, which are responsible for the monitoring and management of their respective fisheries. This report covers only information on herring taken in Alaska state waters, where 20 separate herring fisheries are regulated and monitored by the Alaska Department of Fish and Game (ADFG). Since the early 1970's, fishermen have concentrated on harvesting roe-herring, though some are taken for bait. Her-

Table 14-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Pacific coast and Alaska pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 564,000 t
Current potential yield (CPY) = 184,000 t
Recent average yield (RAY)[1] = 99,000 t

Species and area	Yield (t) RAY	CPY	LTPY	Status of utilization	Status of stock level
Northern anchovy	8,000[1]	7,000	120,000	Full	Near
Pacific sardine	10,000[1]	22,000	250,000	Full	Below
Jack mackerel	9,000[1]	53,000	100,000	Under	Near
Chub mackerel	23,000[1]	36,000	28,000	Full	Near
Pacific herring					
Gulf of Alaska	27,000	34,000	Unknown	Full	Near
Bering Sea	22,000	32,000	Unknown	Full	Near

[1]Mexican catches are typically as large or larger than U.S. catches but were not included in calculation of RAY; 1990-92 average.

. . . INTRODUCTION

ring was harvested in the eastern Bering Sea within the U.S. EEZ by foreign fisheries from 1959 to 1980, when allocations for foreign fishing ended.

SPECIES AND STATUS

Northern Anchovy

The "central subpopulation" of the northern anchovy, which supports U.S. fisheries, has been fished in both California and Mexico for reduction, bait (live or frozen) for anglers, fresh or canned fish for human consumption, animal food, and anchovy paste.

Anchovy landings in California (Fig. 14-1) have fluctuated between less than 10,000 t to nearly 150,000 t since the beginning of the fishery in response to market conditions. Since 1983, U.S. landings have been low (less than 10,000 t), and anchovies have been used mostly for live bait and other nonreduction uses. Anchovy biomass (Fig. 14-1) averaged 290,000 t during 1964-72, increased rapidly to 1,120,000 t in 1974, and declined to 380,000 t in 1982. Biomass increased to about 1,100,000 t in 1986 and then declined to about 300,000 t in the early 1990's. Although total anchovy harvests since 1983 have been less than the theoretical maximum sustainable yield and the historical levels before 1983, abundance continues to decline slowly. Annual harvests declined dramatically after 1990 because the Mexican reduction fishery became unprofitable and ceased. No numerical limits are placed on the live-bait catch in the United States, but there is a 7,000 t quota for other nonreduction uses. Regulations also specify an optimum yield for the reduction fishery based on the biomass of spawning fish.

The well-being of other species, especially the endangered brown pelican which feeds on northern anchovies, is important in anchovy management. Thus, there is a threshold in the optimum-yield formula for the reduction fishery to prevent anchovy depletion and provide adequate forage for marine fishes, mammals, and birds. As a final safeguard against depletion, the management plan closes all fisheries in the second year if the spawning biomass falls below 50,000 t for two consecutive years; the closure continues in subsequent years until the spawning biomass equals or exceeds 50,000 t.

Engraulis mordax

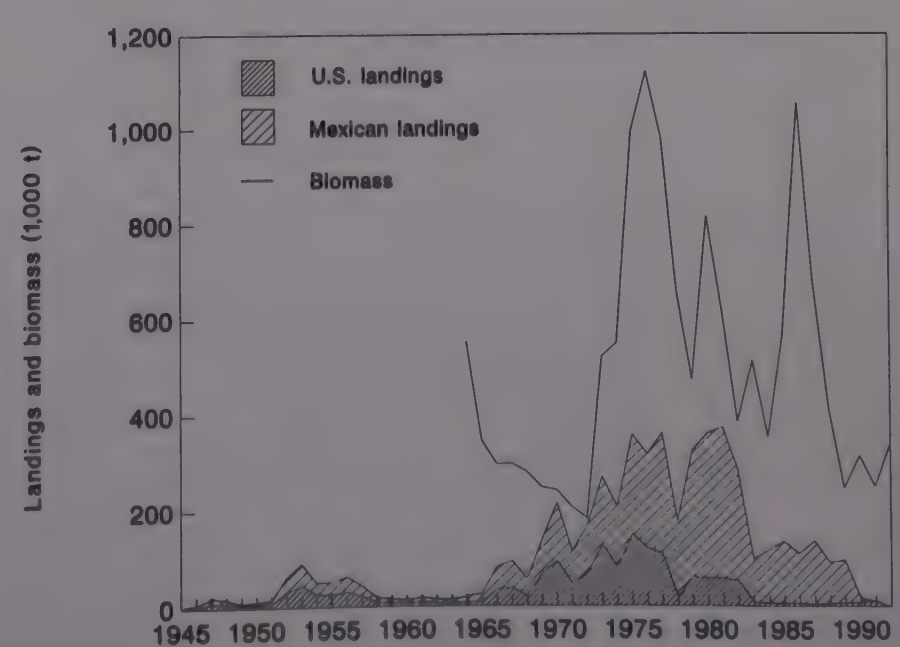


Figure 14-1.—Northern anchovy landings by U.S. and Mexican fleets during 1945-92, and biomass (age 1 and older) from 1964 to 1992.

Pacific Sardine

The California fishery for Pacific sardine dominated the landings of this species, but fisheries also existed off Oregon, Washington, Mexico, and British Columbia when sardines were abundant (Fig. 14-2). In the past, sardines were harvested for fish meal, bait, and human consumption. Currently, there is no fish meal (reduction) fishery, but some sardines are taken for human consumption and bait. Pacific sardine numbers off southern California are now increasing. Since 1986, stock biomass has increased about 40%/year, and the current biomass is at least 100,000 t. Commercial demand for sardines is strong and, as catch quotas grow, the fishery is expected to thrive. Beginning in 1986, only small annual quotas have been allowed for commercial harvest, but quota levels have begun to rise as biomass has increased.

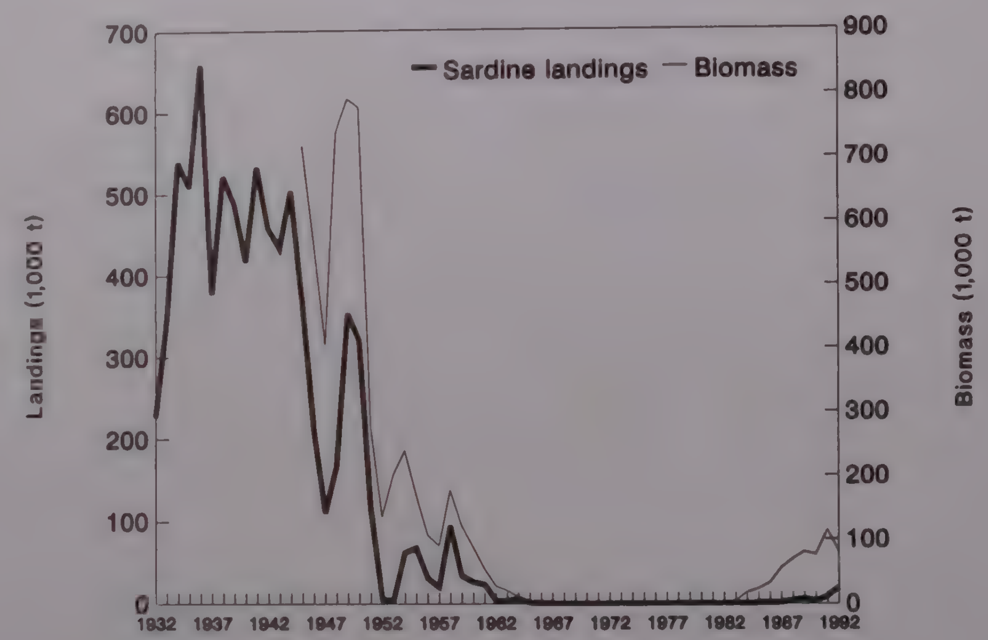


Figure 14-2.—U.S. Pacific sardine landings from the 1932-33 to the 1991-92 seasons and biomass (age 2 and older) from 1945 to 1992.

Jack Mackerel

The large adult jack mackerel found offshore are sometimes caught incidentally by trawlers, particularly those targeting Pacific whiting. During the 1970's, foreign whiting trawlers may have caught 1,000-2,000 t annually, but foreign and joint-venture catches in the 1980's dropped to 100 t or less. The foreign trawl fisheries of the 1970's resulted in jack mackerel management being placed in the groundfish FMP and a bycatch quota of 12,000 t/year (north of lat. 39°N) was set. Restrictions on fishing for other groundfish species, including whiting, were thus avoided. In 1991, interest increased and the catch limit was raised to 52,000 t to allow a mackerel fishery to develop. While that fishery has not yet materialized, strong signs of commercial interest continue. The purse seine fishery for jack mackerel has continued at a low level. There is currently no catch limit.

Jack mackerel has a rather broad distribution, and the stocks consist of a wide variety of ages and sizes. This makes assessment and management difficult. Mackerel stocks are thought to amount to about 1.5 million t, but their potential yield is little more than an educated guess. Development of more reliable estimates of stock size and potential yield awaits collection of more data on age structure and reproductive biology, which could allow interpretation of existing egg and larval survey data.

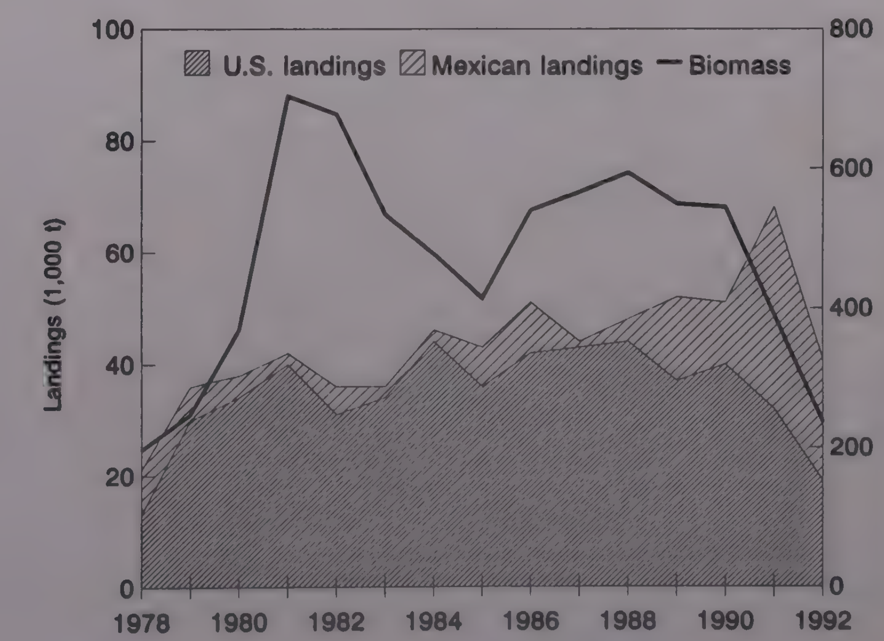
Chub (Pacific) Mackerel

The chub (Pacific) mackerel has a worldwide distribution in temperate and subtropical seas. In the eastern Pacific it ranges from central Mexico to southeastern Alaska, including the Gulf of California, and is most abundant south of Point Conception, Calif. From 1980 to 1989, the California recreational catch averaged 1,462 t per year.

Chub mackerel biomass declined from almost 400,000 t in the early 1930's to less than 100,000 t in the late 1940's and early 1950's. After a brief resurgence in the early 1960's, chub mackerel biomass declined to around 10,000 t (or lower) and remained low until strong year-classes appeared in the late 1970's.

Abundance increased dramatically after 1977 and probably exceeded 200,000 t in every year during the 1980's. Biomass was estimated at about 240,000 t in 1989 but is thought to be declining at present. Analyses of fish-scale deposits in ocean bottom sediments off southern California indicate that the prolonged period of high mackerel biomass levels during the late 1970's and 1980's may have been unusual, and would only be expected to occur, on average, about once every 60 years. In 1985, it was estimated that chub mackerel might sustain average yields of from 26,000 to 29,000 t per year under management systems similar to that currently used to manage the stock by the State of California. The commercial catch is not currently restricted by a quota if the estimated biomass is greater than 135,000 t. If the biomass is between 18,000 and 135,000 t, then a quota equal to 30% of the biomass above 18,000 t is applied. If the biomass is below 18,000 t, then commercial fishing stops.

Figure 14-3.—U.S. and Mexican landings of chub mackerel during 1978-92 and biomass during the same period.

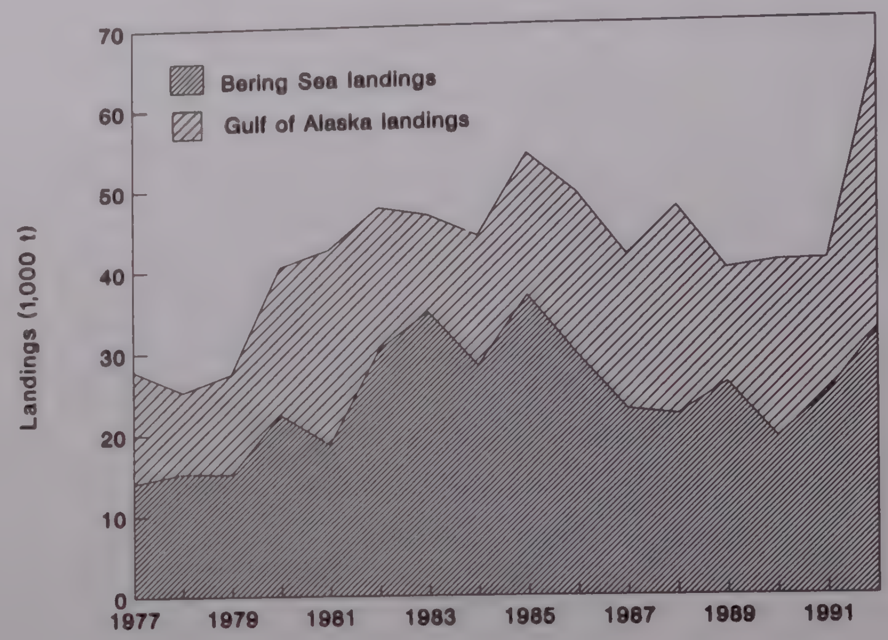


Pacific Herring

Pacific herring in the Gulf of Alaska occurs mainly off southeastern Alaska, in Prince William Sound, and around Kodiak Island-Cook Inlet. Northern Bristol Bay and Norton Sound are major centers of abundance in the Bering Sea. As previously mentioned, herring fisheries occur within state waters and are managed by the ADFG. In recent decades, the fishing industry has concentrated on harvesting roe-herring, though a small amount is taken for food, bait, and other uses. Herring were harvested in the eastern Bering Sea by foreign fleets from 1959 to 1980 when foreign fishing allocations were discontinued. In 1992, 58,069 t of herring with ex-vessel revenue of $31.5 million were harvested. Most was composed of roe-herring (58,000 t), and the rest went for food and bait (8,000 t) and roe-on-kelp (700 t).

Gulf of Alaska harvests have averaged 18,000 t since 1977 (Fig. 14-4). Bering Sea catches rose from 14,000 t in 1977 to a peak catch of nearly 37,000 t in 1985. From 1985 to 1991, the Bering Sea catch declined, but it increased again in 1992.

Figure 14-4.—Pacific herring landings in the Gulf of Alaska and eastern Bering Sea, 1977-92.



. . . Pacific Herring

Herring taken in the Bering Sea groundfish fishery cannot be retained but are counted as part of the catch. Herring bycatch has averaged 2,000-4,000 t per year in the groundfish trawl fishery.

Overall herring abundance in the Gulf of Alaska is at moderate-to-high levels, though some stocks are depressed or declining. A strong 1984 year class is present in most Alaska fisheries. A very strong 1988 year class is reported in southeastern Alaska and Prince William Sound, which will probably increase the abundance of herring in the Gulf of Alaska during 1993. Abundance of herring in the Bering Sea has been declining in the southeast but is stable to increasing in the northeast.

ISSUES

Transboundary Stocks and Jurisdiction

Mackerels, sardines, and anchovies are transboundary stocks exploited by both U.S. and Mexican fleets, but no bilateral management agreement has yet been reached. Harvest levels are increasing in Mexican waters, and the absence of a governing bilateral agreement is undermining management of the fisheries in U.S. waters.

Underutilized Species

Jack mackerel is an underutilized species, while the Pacific sardine is increasing in abundance after decades at low levels. These species may support an increased harvest by U.S. fishermen in the near future. Sardine management will require carefully balancing the need to rehabilitate the stock for the long-term and the immediate needs of fisheries.

Progress

During the last two years, new stock assessment models were developed for northern anchovy, Pacific sardine, and chub mackerel. The new models are more reliable and precise than earlier models used to estimate biomass for these stocks.

Fish spotter data, obtained inexpensively from pilots employed by commercial fishermen, are now used routinely in stock assessment models for northern anchovy, Pacific sardine, and chub mackerel. Information about trends in abundance from fish spotters supplements California Cooperative Oceanic Fisheries Investigation (CalCOFI) ichthyoplankton data used in assessment models to estimate biomass.

NMFS scientists continue to work closely with state biologists and the Pacific Fishery Management Council in managing the stocks. Reports on the status of the current fishery and anchovy stock were completed in 1991.

INTRODUCTION

The Pacific coast groundfish fishery includes 83 species managed by the Pacific Fishery Management Council (PFMC) off Washington, Oregon, and California. These groundfish, which include 12 species of flatfishes and 55 different rockfishes, are harvested commercially by trawl, trap, and hook-and-line gear. Sport fishermen operate from shore, private boats, and charter or commercial passenger fishing vessels.

About ten species each contribute at least 2,000 t to the annual commercial catch (Table 15-1). Pacific whiting (also called hake) dominates and contributed about 70% of the U.S. catch landed in 1992 (and about 25% of the $88 million ex-vessel value). Other valuable species in 1992 were sablefish or black cod ($13.5 million), Dover sole ($10.2 million), thornyheads ($9.0 million), other rockfish ($22.6 million), and other flatfish ($6.6 million).

Various species of groundfish also support popular recreational fisheries off the Pacific coast. The recreational catch in 1986 was 13,900 t. Rockfish and lingcod were the most popular species, composing about 42% of the recreational catch. The value of the recreational fishery cannot be easily estimated.

The commercial catch of Pacific whiting has changed greatly in recent years (Fig. 15-1). A foreign fishery for Pacific whiting began in the mid-1960's and peaked at 240,000 t in 1976. The catch declined as quotas were imposed and a joint-venture (U.S.-foreign) fishery began to develop. In 1989 the joint-venture fishery harvested 203,600 t and completely displaced the foreign Pacific whiting fishery. Since then the fisheries have become totally domestic operations with participation by shoreside and at-sea processors.

Table 15-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Pacific coast groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	328,400 t	(249,441 t, U.S. only)
Current potential yield (CPY) =	273,840 t	(207,999 t)
Recent average yield (RAY)[1] =	370,954 t	(281,763 t)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Pacific whiting[2]	286,191	177,000	221,000	Full	Near
Sablefish	9,580	7,000	6,900	Full	Near
Dover sole	15,330	15,900	16,300	Full	Near
English sole	2,170	1,900	Unknown	Full	Unknown
Petrale sole	1,930	1,100	Unknown	Full	Unknown
Thornyheads M-E-C[3]	7,515	7,900	8,500	Full	Unknown
Widow rockfish	9,534	7,000	6,800	Full	Near
Bocaccio C-M-E[3]	2,540	1,540	1,800	Full	Below
Canary rockfish	2,300	2,900	3,500	Full	Near
Chilipepper rockfish	3,231	3,600	3,600	Full	Near
Pacific ocean perch	1,125	0	1,700	Over	Below
Shortbelly rockfish	0	13,000[4]	18,500	Under	Above
Yellowtail rockfish V-C[3]	4,900	4,600	6,400	Full	Near
Other rockfish	13,580	14,000	Unknown	Unknown	Unknown
Lingcod	3,048	7,000	7,000	Unknown	Unknown
Pacific cod	1,680	3,100	Unknown	Unknown	Unknown
Other fish	6,300	Unknown	Unknown	Unknown	Unknown

[1]1990-92 average, except widow rockfish and bocaccio are for 1989-91.

[2]U.S. and Canada combined landings and potential yield; preliminary U.S. CPY for 1994 is 260,000.

[3]All values are coastwide except V-C is Cape Blanco, Oreg., to U.S.-Canada border; C-M-E is U.S.-Mexican border to Cape Blanco, Oreg. Where a rockfish species is harvested outside the specified area, it is included with "Other rockfish." M-E-C is Pt. Piedras Blancas, Calif., to Cape Elizabeth, Wash.

[4]Interim ABC set at 13,000 t; CPY may be 62,000 t.

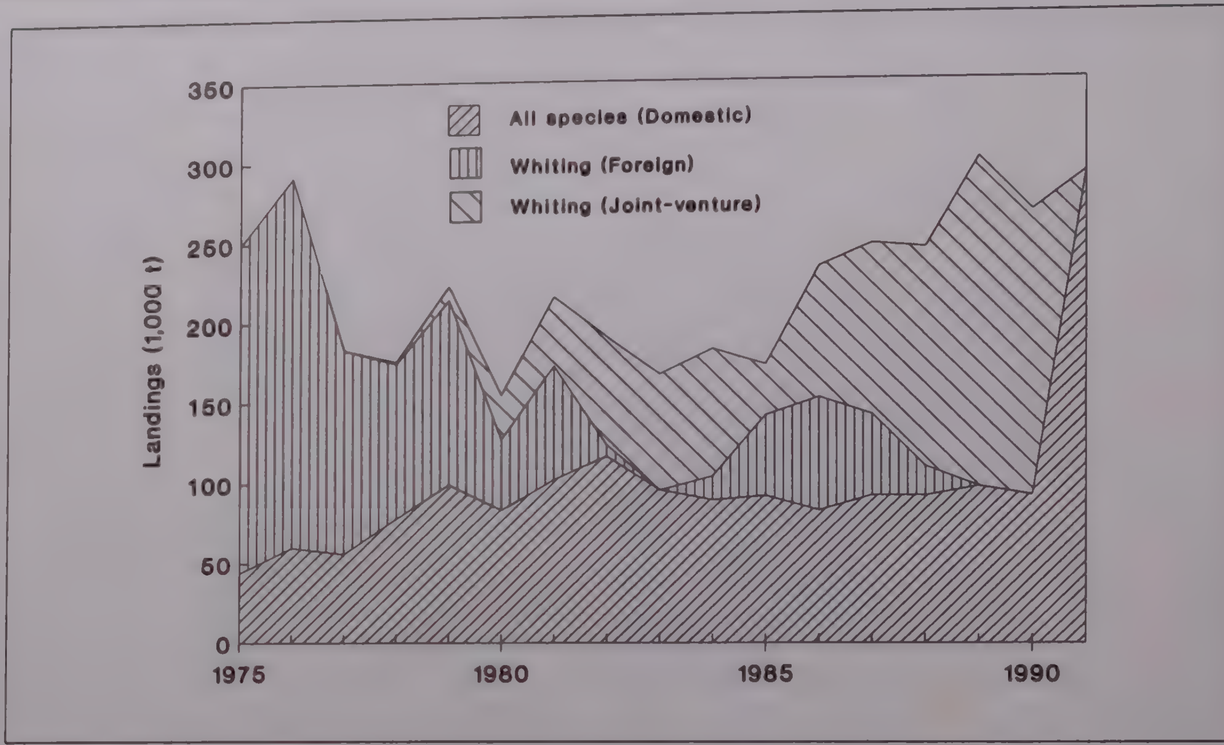


Figure 15-1.—The 16-year trend in Pacific coast groundfish landings. Yield is partitioned into domestic shoreside landings of all species, foreign harvest of Pacific whiting, and joint-venture harvest of Pacific whiting.

SPECIES AND STATUS

Most major west coast groundfishes are now fully harvested (Table 15-1), and recent catches have been controlled by annual quotas and trip limits. Many species can live a long time (50+ years if unfished) and can support only low harvest rates. Sablefish is such a species whose overall population is coming into equilibrium—that is, its current potential yields are approaching its long-term potential yield (Table 15-1). Dover sole, yellowtail rockfish, canary rockfish, and widow rockfish are also near populations levels which will support high long-term sustainable yield. Pacific whiting reached full utilization in 1989 (Fig. 15-2). Its CPY is near its LTPY, but the CPY for whiting will vary substantially because this species has greater short-term natural fluctuations than most other groundfish species. Shortbelly rockfish is underutilized, but a market has not yet developed for this species.

Pacific ocean perch and bocaccio are below population levels which will support their long-term maximum potential yields. The long-lived perch was heavily fished by

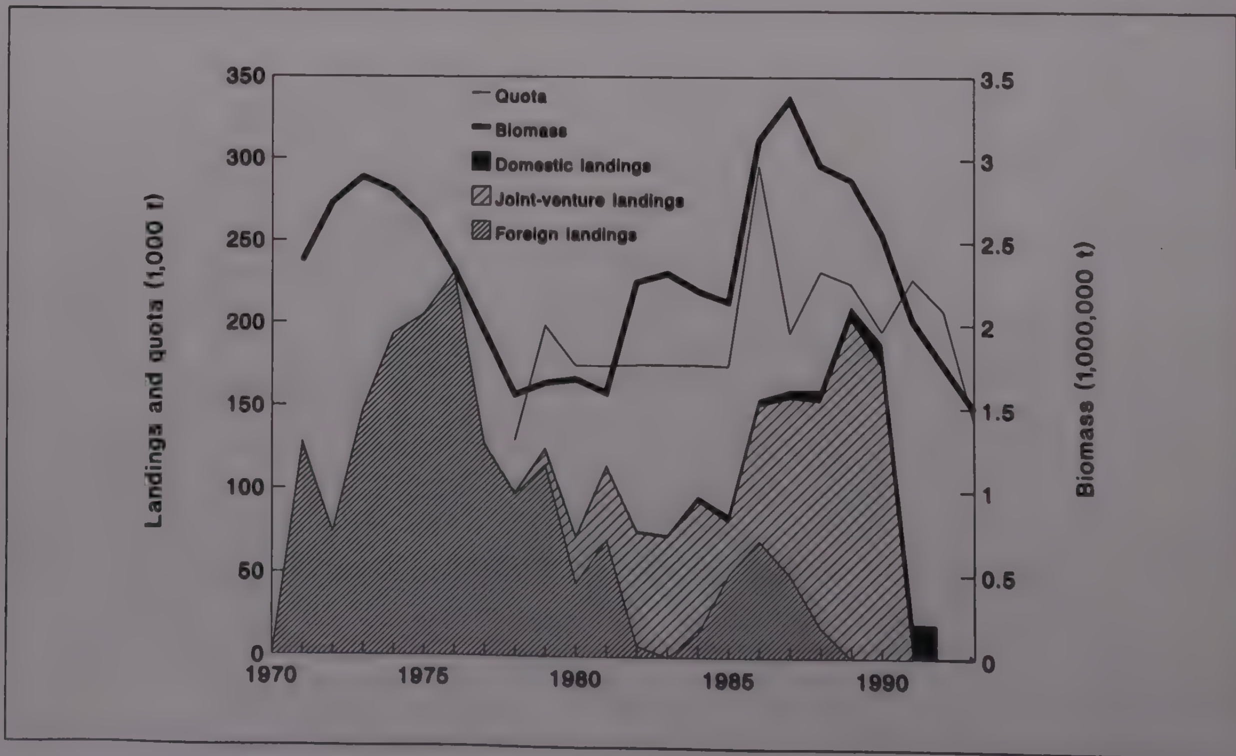


Figure 15-2.—Domestic and foreign catch of Pacific whiting in the U.S. EEZ (1970-92), total quota for harvest in the U.S. EEZ since 1978, and estimated trend in biomass for ages 2 and older.

. . . SPECIES AND STATUS

foreign nations in the 1960's and 1970's. Its CPY is zero to allow population regrowth, though some harvest is allowed as bycatch. Bocaccio is a southern species that has declined due to several years of poor reproduction. The CPY was reduced substantially in 1991, and new trip limits brought the RAY to near this level. Some specific species assessments follow.

Pacific Whiting

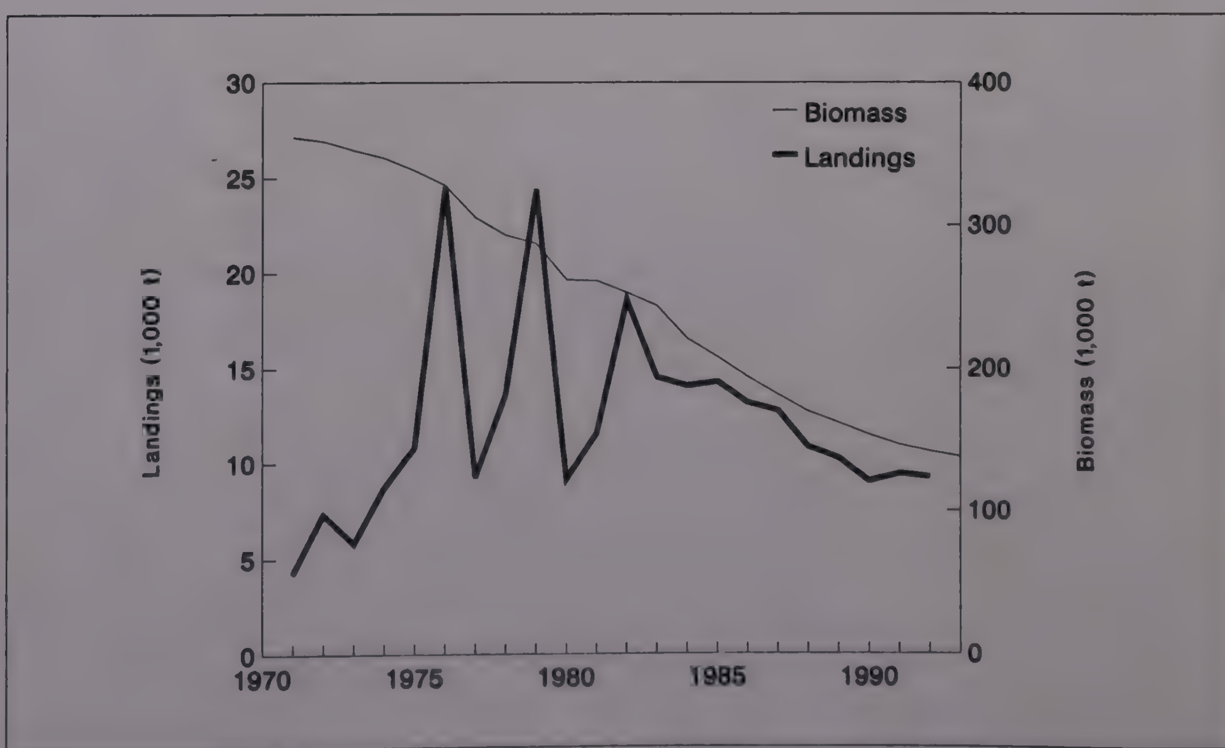
Pacific whiting are well studied, with accurate aging, hydroacoustic stock surveys, and an assessment model that analyzes all fishery and survey data while taking into account environmental effects on the stock. However, additional work is needed to improve 3-5 year forecasts. The greatest management problems for this species are allocation between onshore and offshore fisheries, bycatch of salmon, and allocation of catch between the United States and Canada.

Merluccius productus

Sablefish

Sablefish biomass and landings are shown in Figure 15-3, but stock assessment is hampered by lack of data. The size and age composition of the commercial catch has only been monitored since 1986, and the magnitude of current and historical discarded catch is not well known. Pot surveys indicate a declining stock, and trawl surveys on the continental slope have only been conducted in part of the species' wide range. Imprecise age and stock determinations must be clarified by further research. Allocation between fixed gears (primarily pot and longliners which target on sablefish) and trawlers (which catch sablefish in association with other species) remains a management issue.

Figure 15-3.—Total landings (domestic and foreign) of sablefish in the U.S. EEZ, 1970-92, and the estimated trend in biomass for ages 3 and older.



Dover Sole

Dover sole stock assessment suffers from the same lack of extensive trawl survey data and similar stock mixing problems as sablefish. Although fishery catch and fishing effort data have been collected for several years, interpretation has been confounded by changing market conditions impacting the fishery.

Other Flatfish

New assessments for English and petrale soles and arrowtooth flounder were conducted in 1993. English and petrale soles have long histories of stable harvests, but they were last assessed in the mid-1980's. The arrowtooth flounder fishery has recently expanded and has never been assessed. All three assessments are hampered by the limited and inadequate survey data.

Thornyhead

Thornyheads are harvested in deep water with sablefish and Dover sole. Their catch nearly tripled from 1987 to 1990 owing to increased market demand. Data for a full stock assessment will be difficult to obtain, but the extremely long life of shortspine thornyheads indicates that their harvest rate must remain lower than sablefish and Dover sole.

Rockfish

Rockfish are hard to assess because of their low mortality rates and high variability in trawl surveys. The age of the six major species caught has been well monitored and used in catch-at-age analyses, but better survey methods must be developed for more accurate stock assessments. Comparable assessment of the 50+ lesser rockfish species is not possible because of the lack of fishery or survey data.

ISSUES

Scientific Advice and Adequacy of Assessments

Assessment of the status of these groundfish stocks requires improved data on catches, extensive research surveys, and information on species interactions. Currently, the fraction discarded at sea is poorly known, rockfish species composition is inadequately sampled in some strata, and biological data are collected only from selected species. An at-sea observer program would improve the monitoring of these stocks by providing information on discarding practices and an additional opportunity for collection of biological data.

Bycatch and Multispecies Interactions

West Coast groundfish fisheries are characterized by a large number of species caught during a fishing trip. This complicates management because any action taken with respect to one species may adversely affect several others, either because of changes in fishing practices or due to biological interactions. Since all species cannot withstand the same harvesting pressure, management controls need to be developed which adequately protect low productivity species while allowing full exploitation of high productivity species.

Allocation

A difficult problem is managing the excess harvesting capacity: There are simply too many boats and gear for the fish available. Trip limits achieve a desired year-round season for most species, but are economically inefficient and cause discarding which is not monitored. Some alleviation of discard and enforcement problems was achieved in 1992 by replacing most trip limits with biweekly cumulative vessel limits. A license limitation program will be implemented in 1994 which should further reduce these problems.

Management Concerns

Allocation of available catch quotas to different groups is a difficult and controversial management problem. The PFMC must cope with a U.S.-Canada whiting allocation, onshore-offshore whiting allocation, fixed gear/trawl allocation of sablefish, and recreational-commercial competition for some rockfishes. Technical assessment of these issues generally rests on an economic analysis that rarely has adequate information on all sectors of the fishing industry. The license limitation program should ease some of these problems, and the Council has identified individual transferable shares as a potential long-term solution.

INTRODUCTION

Important invertebrate fisheries in the Western Pacific have included spiny and slipper lobsters and the gold, bamboo, and pink corals. The fisheries are relatively recent and range from the Hawaiian Islands EEZ (Fig. 16-1) to Guam, American Samoa, and various U.S. Pacific islands.

The Northwestern Hawaiian Islands (NWHI) lobster fishery began in 1977, and a Fishery Management Plan (FMP) was implemented in 1983. The NWHI are uninhabited, and there is no recreational fishery—all harvests are commercial. Commercial lobster vessels are all relatively large and carry about 500-1,200 traps which are used on 1- to 2-month fishing trips. Fishing effort from 1985 to 1990 was close to 1 million trap-hauls per year, about the level which achieves LTPY (Table 16-1). Eighty percent of the recent landings have been spiny lobster (Fig. 16-2). The fishery is managed by the Western Pacific Fishery Management Council (WPFMC).

A short-lived (1974-79) fishery for several gold and bamboo corals and for pink coral existed off Makapu'u Point, Oahu, Hawaii. Since then, the prohibitive cost of fishing such difficult-to-harvest, deep-water corals has stifled U.S. exploitation. With the exception of one aborted attempt at Hancock Seamount in the Hawaiian EEZ in 1988, legal domestic harvesting (and possibly, illegal foreign harvest) of precious coral within the EEZ (excluding the relatively shallow-water black corals) has been nonexistent for 12 years (Fig. 16-3). There are no recreational coral fisheries. Precious corals within the EEZ are managed under the Precious Coral FMP, set up in September 1983 by the WPFMC.

Table 16-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level of Western Pacific invertebrate fisheries.

Species group	Yield (t) RAY[1]	CPY[2]	LTPY[3]	Status of utilization	Status of stock level
Spiny and slipper lobsters	220	0	120	Over	Below

[1] 1990-92 average.
[2] The fishery was closed in 1993.
[3] Estimate reduced from 1992 due to climate change impacts to carrying capacity.

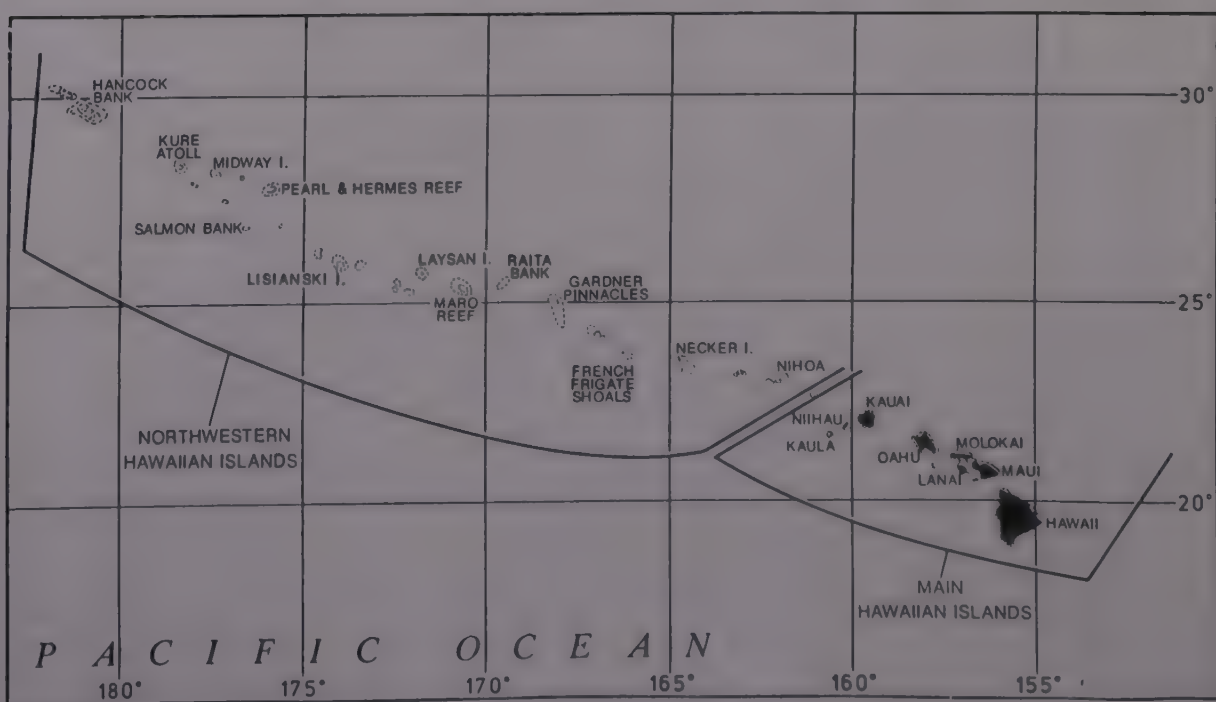


Figure16-1.—The main (MHI) and Northwestern (NWHI) Hawaiian Islands.

SPECIES AND STATUS

Lobster

Spiny and slipper lobsters are fished in the Western Pacific, primarily in the NWHI area (Fig. 16-1). They are not abundant outside this region.

The NWHI lobster landings and catch per unit effort (CPUE) have dropped substantially since 1989 (Fig. 16-2). Concern that the NWHI lobsters were overexploited during 1990-91 prompted the WPFMC to close the fishery during May-November 1991. A limited-entry program was begun in 1992 with an annual harvest quota. Fishing effort in 1992 was 722,000 trap-hauls, and the value of the fishery was $2 million. This compares with 296,000 trap-hauls in 1991 and revenues of $1 million. The fishery was closed in 1993.

The LTPY estimate was reduced from 560 t because a reanalysis of data indicated lower carrying capacity.

Coral

Fishing for coral is by regular or "experimental" fishing permit only. The FMP regulates precious coral fisheries within the EEZ management unit seaward of the MHI and NWHI, Guam, American Samoa, and the U.S. Pacific island possessions of Johnston Atoll, Kingman Reef, and Palmyra, Wake, Jarvis, Howland, and Baker Islands.

Figure 16-2.—Spiny and slipper lobster landings and fishing effort in Hawaii, 1977-92.

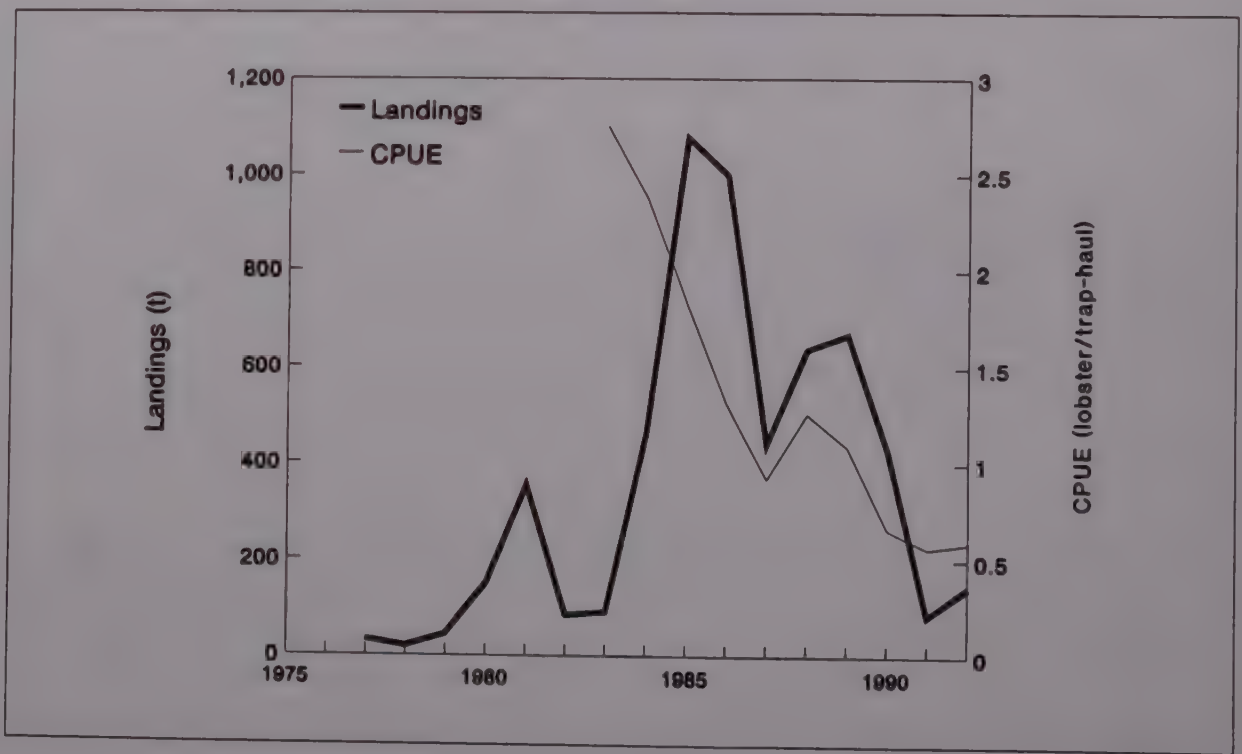
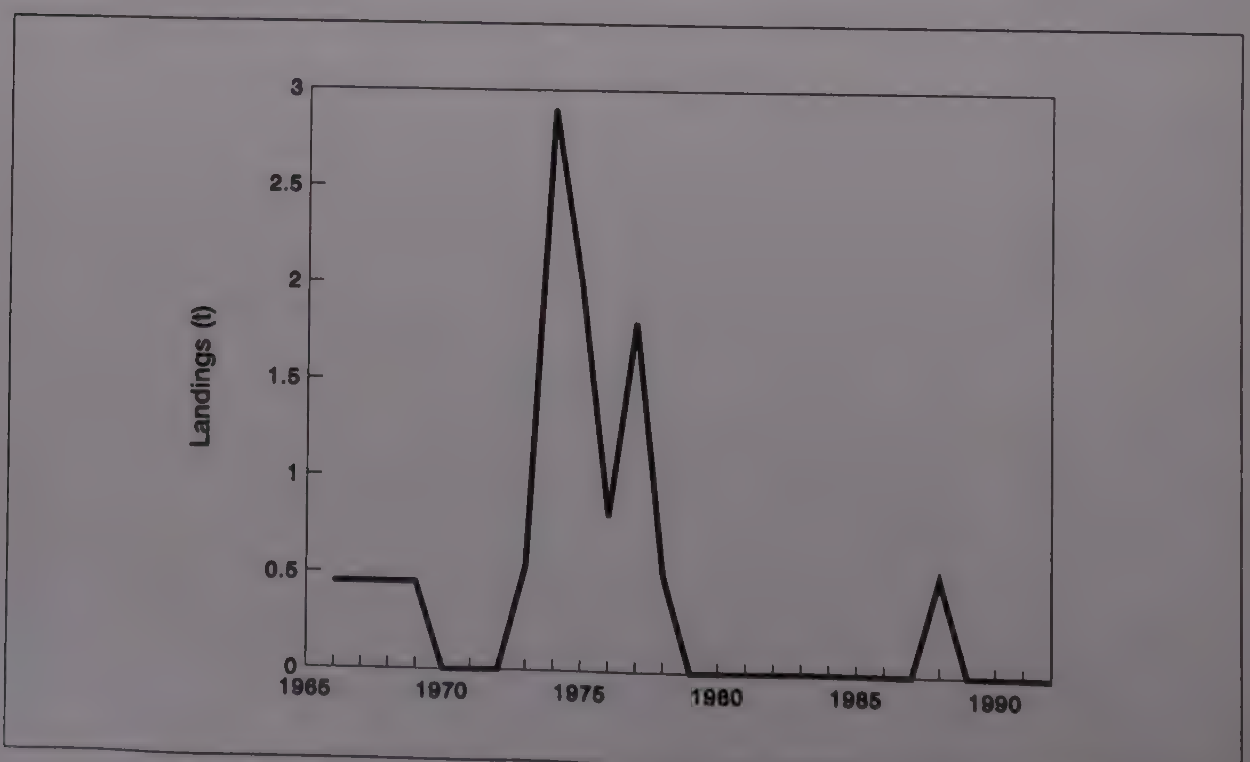


Figure 16-3.—Landings of precious corals from Hawaiian waters, 1966-92.



ISSUES

Scientific Advice and Adequacy of Assessments

Management of the spiny and slipper lobsters is difficult because the number of young lobsters entering the fishery each year varies widely. We need to know the cause of this variation so we can predict it. Preliminary research suggests that annual variation in current flow along the Hawaiian ridge may be the cause, but we need to pursue these studies to verify this hypothesis.

WESTERN PACIFIC BOTTOMFISH AND ARMORHEAD FISHERIES

INTRODUCTION

The bottomfish fishery geographically encompasses the Main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), the Territory of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and the Territory of American Samoa (Table 17-1). In contrast, the pelagic armorhead is fished on several undersea peaks called "seamounts."

The Guam, CNMI, Samoa, and MHI fisheries employ relatively small vessels on 1-day trips close to port; much of the catch is taken by either part-time or sport fishermen. In contrast, NWHI species are fished by full-time fishermen in relatively large vessels on trips of up to 10 days and far from port. Fishermen use the handlining technique in which a single weighted line with several baited hooks is raised and lowered with a powered reel. The bottomfish fisheries are managed jointly by the Western Pacific Fishery Management Council (WPFMC), Territories, Commonwealth, and State.

The armorhead was fished by the Japanese and, until some 15 years ago, by bottom trawlers from the former Soviet Union. The catch peaked in 1972 with catch rates exceeding 60 t/hour but then dropped to very low levels. The combined population on all seamounts collapsed to about 0.5% of the 1972 level by the early

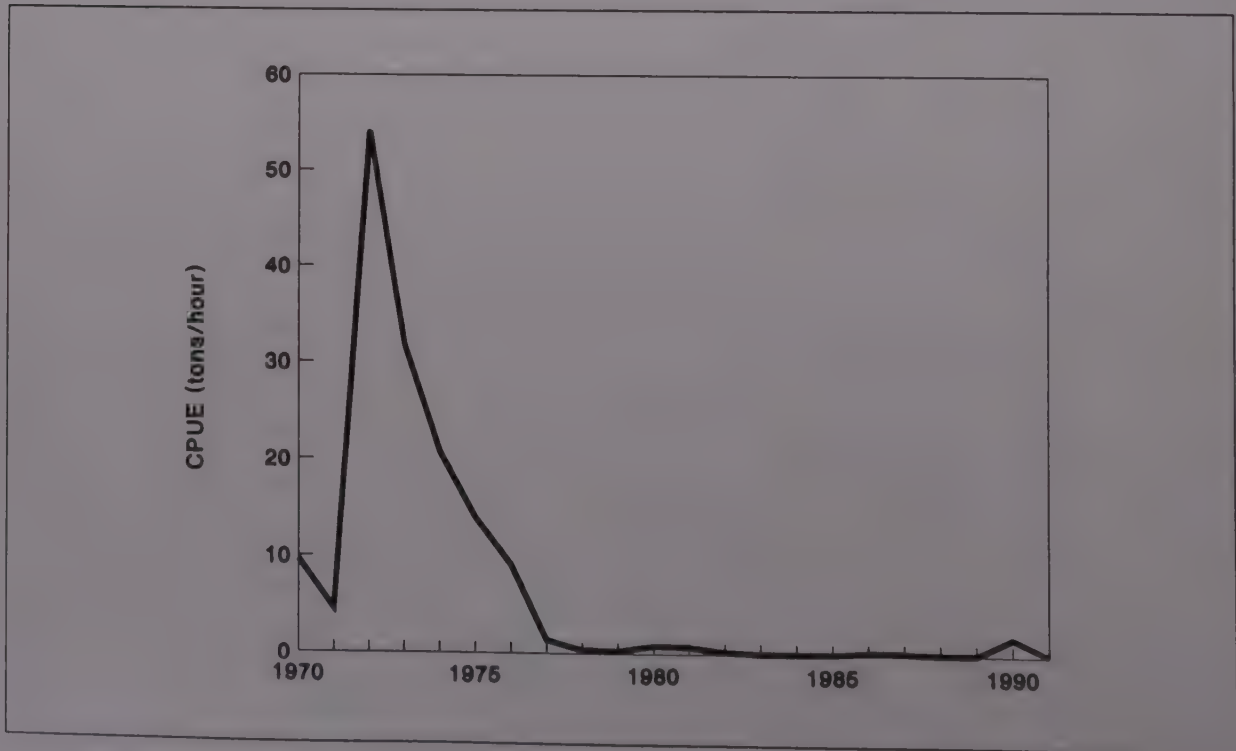
Table 17-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of bottomfish and pelagic armorheads. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) =	2,812 t
Current potential yield (CPY) =	701 t
Recent average yield (RAY)[1] =	443 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Bottomfish					
MHI	286	286	274	Over	Below
NWHI	124	335	335	Under	Near
American Samoa	7	31	31	Under	Near
Guam	22	25	25	Under	Near
CNMI	4	24	24	Under	Near
Pelagic armorhead	0	0	2,123	Over	Below

[1]1990-92 average.

Figure 17-1.—Annual catch per unit of effort (CPUE) of pelagic armorhead taken by the commercial Japanese trawl fishery from central North Pacific seamounts, 1970-91.



. . . INTRODUCTION

1980's (Fig. 17-1). The catch was regulated on the Hancock Seamounts in 1977 under a Preliminary Management Plan, but catches still declined and fishing was stopped in 1984. In 1986, under the bottomfish and seamount groundfish FMP, a 6-year fishing moratorium was imposed on the Hancock Seamounts. The moratorium was extended for an additional 6-year period in 1992.

SPECIES AND STATUS

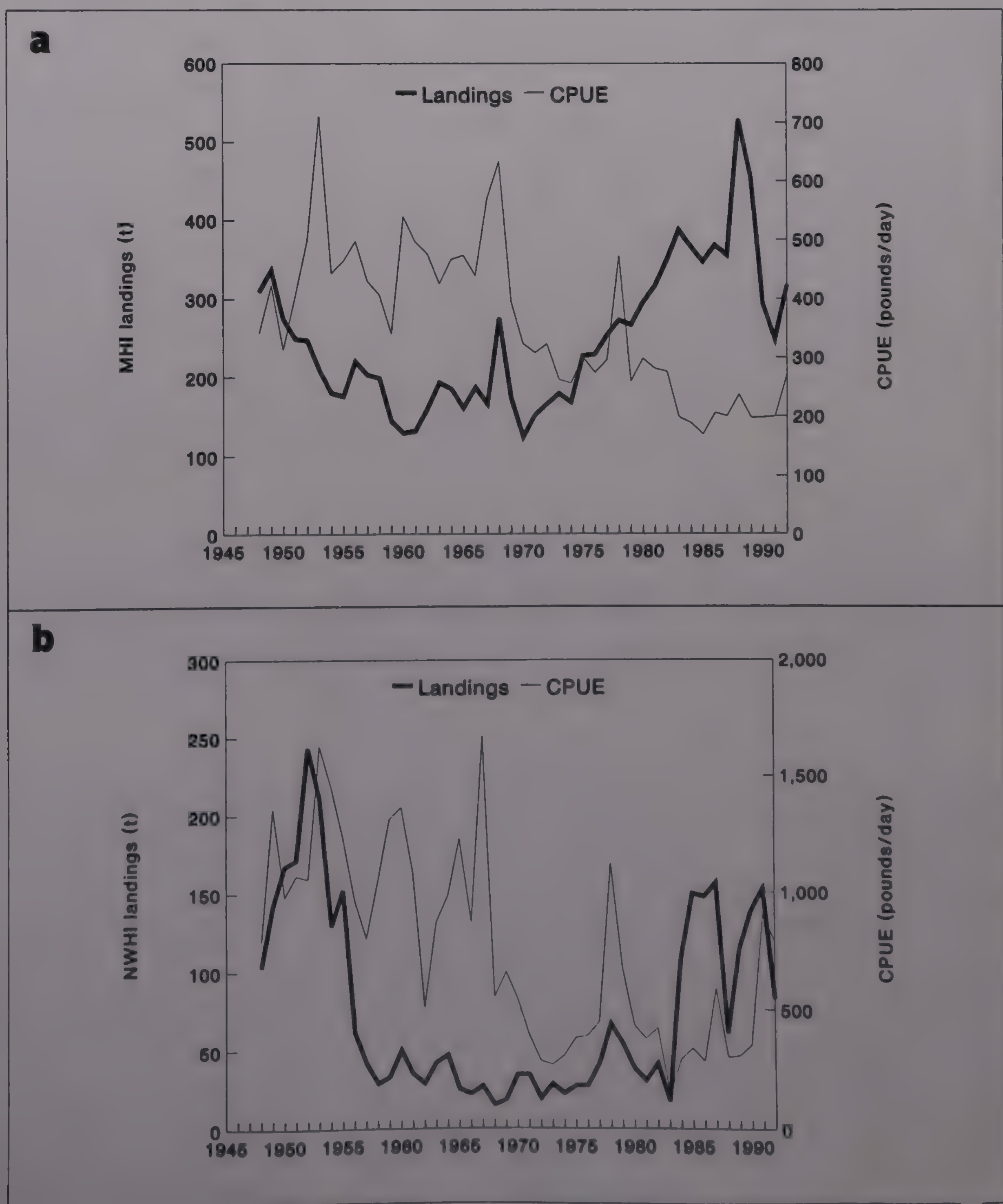
Bottomfish

In Hawaii, the bottomfish species fished include several snappers, jacks, and groupers, whereas in the more tropical waters of Guam, CNMI, and Samoa the fishes include a more diverse assortment of species within the same families as well as several species of emperors. These species are found on rock and coral bottoms at depths of 50-400 m.

Catch weight, size, and fishing effort data are collected for each species in the five areas. However, the sampling programs vary in scope between the areas. About 90% of the total catch is taken in Hawaii, nearly equally divided between the MHI and the NWHI (Fig. 17-2).

Stock assessments, though somewhat limited, indicate that the spawning stock of at least four major MHI species (opakapaka, ehu, onaga, and ulua) are at only 20-30% of original levels.

Figure 17-2.—U.S. landings and catch per unit of effort (CPUE) of bottomfish from fisheries off the a) main Hawaiian Islands (MHI) and b) Northwestern Hawaiian Islands (NWHI), 1948-92.



Pelagic Armorhead

The seamount groundfish fishery targets just one species: the pelagic armorhead. It is fished on many of the undersea peaks of the northern Hawaiian Ridge and southern Emperor seamount chains. Though only a small area, the Hancock Seamounts are within the U.S. EEZ. The long-term potential yield (Table 17-1) is 2,123 t, but further recovery is needed to achieve that level.

Standardized stock assessments began in 1985. Research cruises focus on the Southeast Hancock Seamount and sample the armorhead stock with bottom longlines, calibrated against Japanese trawling effort. Catch rates vary but have not shown the increases expected after the fishing moratorium was implemented (Fig. 17-3). Closure of only the small U.S.-EEZ portion of the armorhead's distribution may not be sufficient to allow population recovery, but it is the only portion of the habitat currently under management.

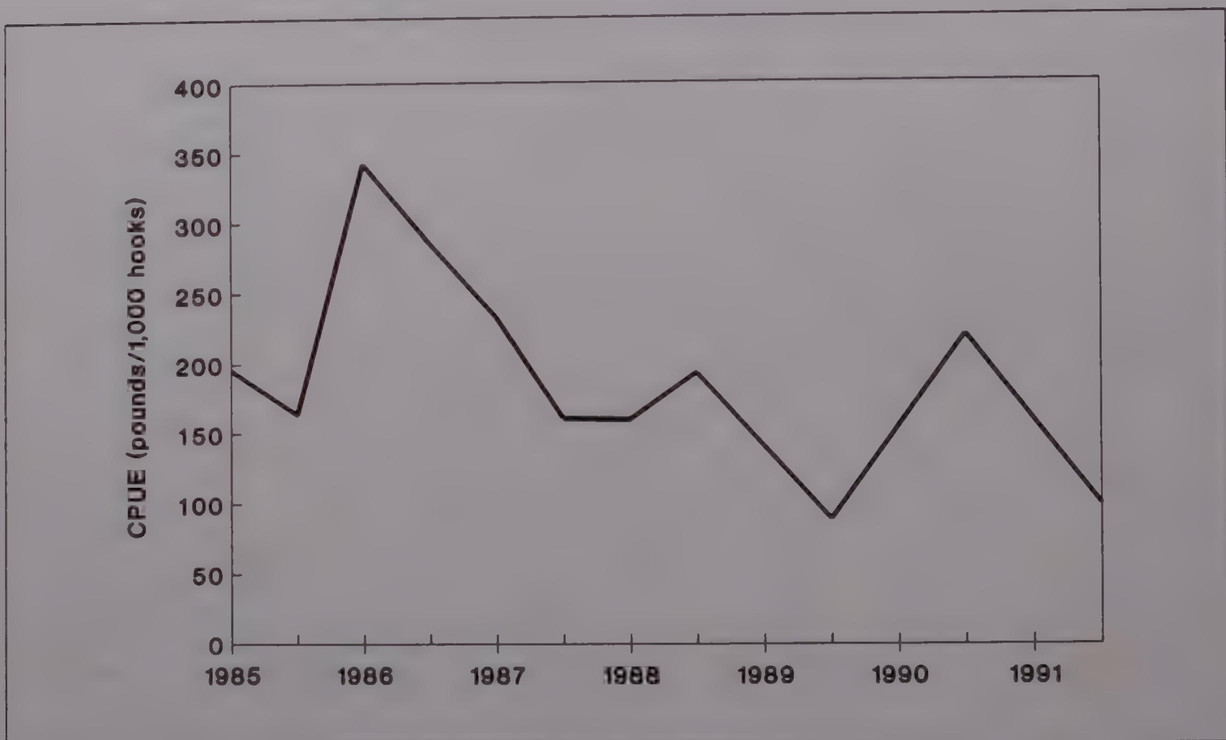


Figure 17-3.—Catch per unit of effort (CPUE) for pelagic armorhead taken on bottom longlines during research cruises to Southeast Hancock Seamount, 1985-92.

ISSUES

Scientific Advice and Adequacy of Assessments

Adequacy of the biological and catch data collected is a primary management concern for the Western Pacific bottomfish fishery. For example, the reproduction of many of the important species in Guam, CNMI, and Samoa is unknown, and spawning numbers cannot be computed.

Transboundary Stocks and Jurisdiction

The primary issue now for the pelagic armorhead and its seamount fishery is how to halt the armorhead harvest outside the U.S. EEZ via some form of international agreement so the stock can recover.

Management Concerns

The spawning stocks of at least four important MHI fishes (opakapaka, ehu, onaga, and ulua) appear to be at about 20-30% of original levels. Thus, overutilization is a concern, and the WPFMC has recommended that the state of Hawaii take action to prevent overfishing because the fishery and the bottomfish habitat are predominantly within state waters.

Progress

Research continues to identify nursery habitat for juvenile snappers and groupers in Hawaii. Age and growth curves have been extended to include early juvenile stages. Multispecies dynamic production models are being applied to catch-and-effort data from the Northwestern Hawaiian Islands fishery.

INTRODUCTION

The fishes in this group range the high seas and often are outside U.S. fisheries management jurisdiction. The status of several is either uncertain or unknown. Some species are sought vigorously by both commercial and sport fishermen.

During 1970-80, the eastern tropical Pacific (ETP) tuna fishery was expanding and was dominated by the United States. Fishing became less profitable in the 1980's, and many U.S. fishermen quit or moved to the central-western Pacific (CWP), leaving Mexico, with over 50 purse seiners, the dominant fleet in the ETP. U.S. vessels decreased to about 10 in 1990-92 in response to dolphin mortality concerns. Purse seiners (all countries) in the ETP in 1991 numbered over 125.

Currently, there is no international tuna management in the ETP; each coastal nation regulates fishing within its own EEZ. Until 1980 the Inter-American Tropical Tuna Commission (IATTC) regulated the international fishery with catch quotas. Since then, IATTC regulations have been suspended because Mexico is not a Commission member.

Also, there is no overall resource management program in the CWP, though the Forum Fisheries Agency (FFA), which represents the concerned South Pacific island nations, has instituted a licensing program for foreign (distant-water) fishing fleets through access agreements. The U.S. fleet is currently limited to 50 purse seiners in the FFA region under an access agreement (South Pacific Regional Tuna Treaty).

Presently, there are no management regimes for the North or South Pacific albacore fisheries. In the South Pacific, multilateral discussions between Pacific island nations and distant-water fishing nations, including the United States, were held to explore various management schemes. Following the demise of drift gillnet fishing in the South Pacific, these negotiations were suspended in 1992 due to lack of further interest.

U.S. billfish fisheries (except for swordfish) have been dwarfed by foreign fisheries (mostly longline and drift gillnet). There is no international authority managing these species in the Pacific. U.S. management authority for billfish and tuna rests with the Western Pacific Regional Fishery Management Council for Hawaiian and Western Pacific waters, and with the Pacific Fishery Management Council for North American waters (although the latter has delegated management to the State of California for swordfish, striped marlin, and some sharks).

SPECIES AND STATUS

"Highly migratory" pelagic species include tropical tunas (yellowfin, bigeye, and skipjack), albacore, billfishes, swordfish, sharks, and other large pelagic fishes. Most are caught commercially, but some, especially certain billfishes, support important recreational fisheries as well.

Tropical Tunas

Longline gear is used to catch yellowfin and bigeye tunas across the Pacific, whereas the purse seine is the primary gear in the ETP and the CWP regions for capture of yellowfin and skipjack tunas.

Purse seine fishing in both the ETP and CWP is conducted generally between lat. 20°N and 20°S. Longline fishing extends to higher latitudes (e.g. to 40°N). Mexico is the primary fishing nation in the ETP. Others include the United States, Vanuatu, Venezuela, and some other coastal nations. Major fishing nations in the CWP are the United States, Japan, the Republic of Korea, and Taiwan. Current, recent, and long-term potential yields for the various species are given in Table 18-1.

Gears used in the CWP fishery include purse seine, ring net, handline, pole-and-line, and longline. Purse seiners, dominated by U.S. and Japanese fleets but currently challenged by Korean and Taiwanese fleets, take 30-50% of the yellowfin tuna catch. In 1989 the total number

. . . Tropical Tunas

of purse seiners in the CWP was more than 120. In 1990-92 about 42 U.S. seiners operated in the CWP.

About 90% of the Pacific yellowfin tuna catch is taken by purse seine, pole-and-line, longline, and handline. Purse seiners account for 30-50% of the catch. Virtually all skipjack tuna is taken by pole-and-line and purse seine. Most of the bigeye tuna catch is taken by longline gear.

More skipjack tuna are caught than any other tunas. Recent average yield (RAY) of Pacific skipjack tuna by U.S. and foreign fleets is 752,200 t from the CWP (Fig. 18-1) and 77,600 t from the ETP; recreational catches are small. The species is believed underutilized, though the long-term potential yield (LTPY) is unknown. The annual dockside ex-vessel revenue of the Pacific skipjack tuna catch is about $590 million, and for yellowfin tuna it is well in excess of $410 million. These figures are based on a conservative dockside price of $700/t for both species.

The recent average yield of yellowfin tuna for the entire Pacific is about 585,000 t (Table 18-1), distributed about equally between the ETP and the CWP (Fig. 18-2). Recent assessments of yellowfin tuna indicate that the LTPY for the ETP is about 250,000 t, making this resource fully utilized. The LTPY for the CWP is unknown because a comprehensive analysis of potential yield has not been performed. However, catch rates are fairly steady, and preliminary analyses of stock condition suggest that the fishery may be nearing full production.

The recent average yield of bigeye tuna for the entire Pacific is about 134,000 t (Table 18-1) generating ex-vessel revenues of about $1 billion, with most of the catch taken by foreign longline fisheries. Bigeye tuna is mostly sold for raw consumption as "sashimi" and brings the highest dockside price of any tropical tuna (about $7,000/t). The best available estimates of LTPY and CPY are about 160,000 t (Table 18-1), and the current level of fishing effort is the highest recorded to date. Recent catch rates have been low but stable, and the stock may be fully utilized.

Table 18-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for Pacific highly migratory species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	1,798,820 t	(261,395 t, U.S. only)
Current potential yield (CPY) =	1,718,233 t	(249,685 t)
Recent average yield (RAY)[1, 2] =	1,707,299 t	(248,096 t)

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Yellowfin tuna (CWP[3])	320,233	Unknown	Unknown	Unknown	Near
Yellowfin tuna (ETP[4])	265,066	250,000	250,000	Full	Near
Skipjack tuna (CWP)	752,200	Unknown	Unknown	Under	Near
Skipjack tuna (ETP)	77,600	Unknown	Unknown	Under	Near
Albacore (North Pacific)	39,613	Unknown	120,000	Over	Below
Albacore (South Pacific)	24,367	Unknown	Unknown	Unknown	Near
Bigeye tuna	134,000	160,000	160,000	Full	Near
Blue marlin	20,300	Unknown	23,500	Over	Below
Black marlin	2,300	Unknown	Unknown	Unknown	Near
Striped marlin	14,600	Unknown	Unkown	Under	Near
Sailfish and shortbill spearfish	5,100	Unknown	Unknown	Unknown	Near
Swordfish	28,000	Unknown	25,000	Under	Near
Wahoo	420	Unknown	Unknown	Unknown	Near
Dolphin (mahimahi)	23,500	Unknown	Unknown	Unknown	Near
Pelagic sharks	Unknown	Unknown	Unknown	Unknown	Unknown

[1]1988-90 average; 1989-91 for yellowfin and skipjack tunas.
[2]Includes U.S. and foreign landings. (248,096 t, U.S. landings: tunas, swordfish, and billfish only)
[3]CWP=central-western Pacific Ocean.
[4]ETP=eastern tropical Pacific Ocean.

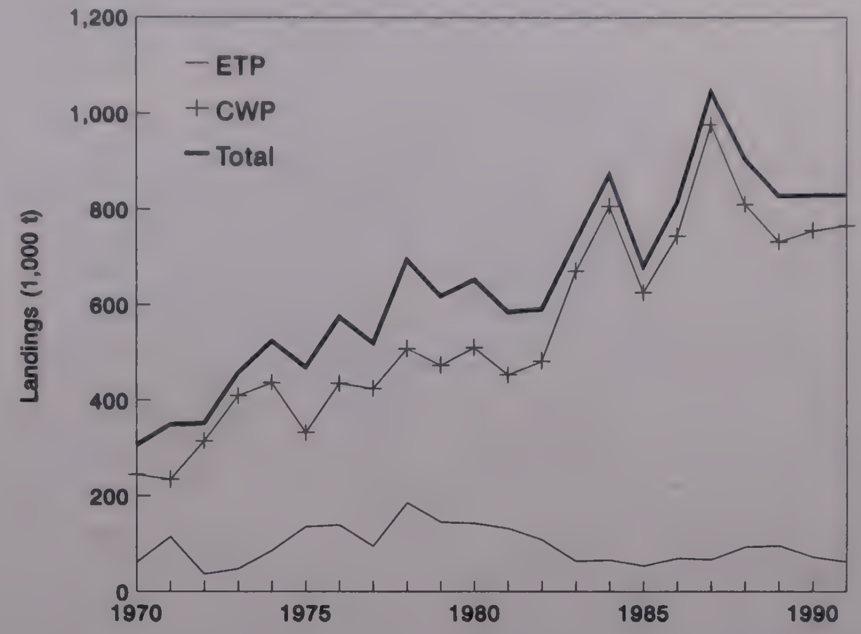


Figure 18-1.—U.S. and foreign skipjack tuna landings from the Pacific Ocean (Total), the eastern tropical Pacific (ETP), and the central-western Pacific (CWP), 1970-91.

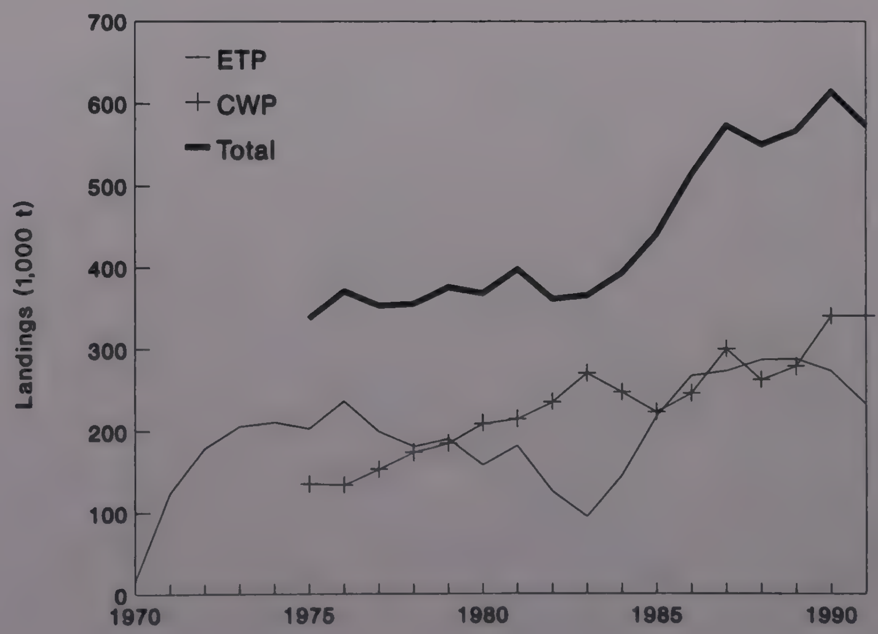


Figure 18-2.—U.S. and foreign yellowfin tuna landings from the Pacific Ocean (Total), the eastern tropical Pacific (ETP), and the central-western Pacific (CWP), 1970-91.

Albacore

Albacore is fished from the northern limits of the North Pacific Transition Zone (NPTZ) to about lat. 15°N, and from Japan to North America. In the South Pacific, it is fished from about lat. 15°S to the southern limits of the Subtropical Convergence Zone (STCZ) and from South America to Australia.

In the North Pacific, albacore is fished primarily by longline, pole-and-line, trolling, and until recently, drift gillnet. Longline gear is used in the lower latitudes, and accounts for about 20-25% of the current catches. The surface fisheries (pole-and-line, troll) operate in the higher latitudes of the NPTZ and account for 75-80% of the catches. The U.S. fishery in the North Pacific extends from the middle of the North Pacific to North America and uses between 500 and 2,000 vessels. Based on a dockside price of $2,200/t, the annual ex-vessel revenue of the North Pacific albacore catch is about $140 million.

South Pacific albacore is fished primarily by longline and trolling. As in the north, longliners operate nearer the equator.

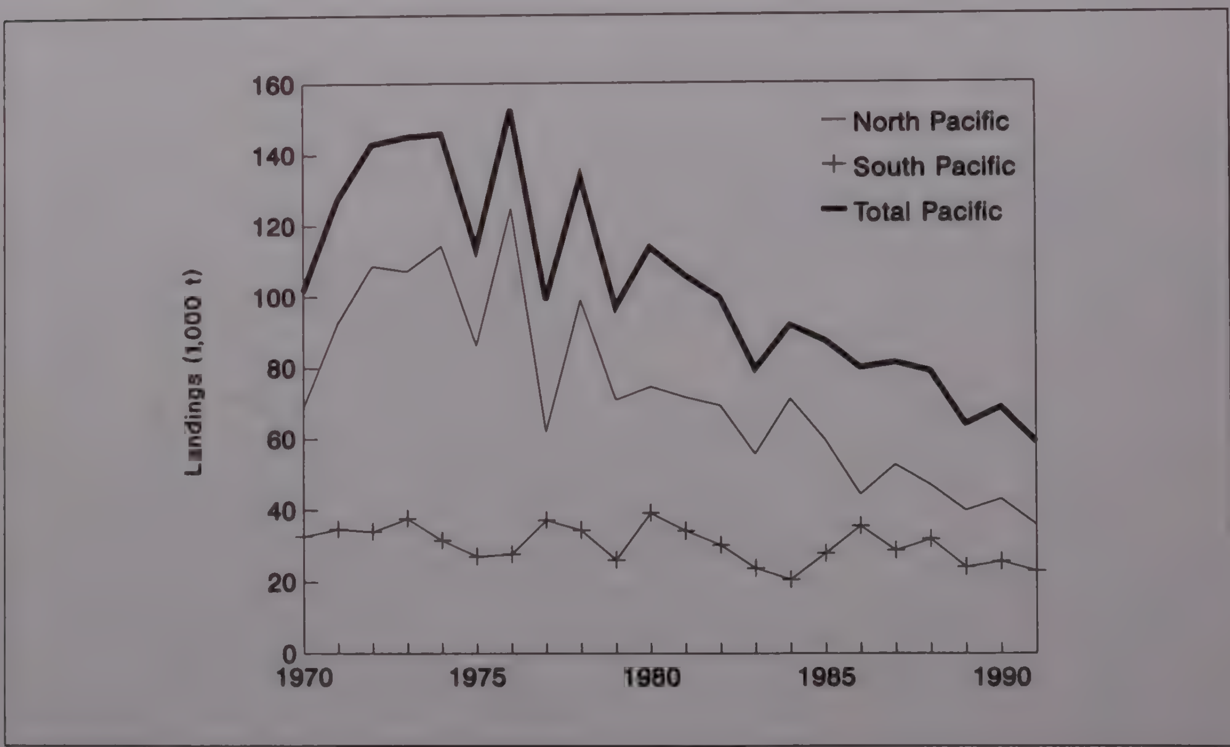
. . . Albacore

Surface gear is fished in the Tasman Sea and in the STCZ at about long. 160°W. In 1992, about 55 U.S. trollers fished the South Pacific.

The Pacific albacore (both the north and south stocks) has a long history of exploitation (Fig. 18-3). Recent development of a large surface fishery in the South Pacific, in addition to the longline fishery, has changed the previous stock assessments from "fully exploited," under a longline-only fishery, to "unknown." No LTPY has yet been estimated, but a comprehensive assessment is needed due to the rapid expansion of the troll fishery and termination of the driftnet fishery in 1991.

In the North Pacific, the total catch, catch rates, and fishing effort in the U.S. troll fishery and the Japanese pole-and-line fishery have all been declining (Fig. 18-3). Previous assessments estimated LTPY near 120,000 t and stock production at or above LTPY in the 1970's. This high production, coupled with a drift gillnet fishery from 1980 to 1992 (for which statistics are incomplete), probably overutilized the stock. A comprehensive assessment is needed due to the changing fisheries.

Figure 18-3.—U.S. and foreign albacore landings from the Pacific Ocean (Total), the North Pacific, and the South Pacific, 1970-91.



Swordfish

Swordfish are distributed throughout the temperate, subtropical, and tropical waters of the Pacific. Much of the Pacific-wide catch is taken by the Japanese longline fishery directed at tunas, with the rest taken by surface gears such as harpoons, handlines, and until recently, drift gillnets. Coastal fisheries occur off the United States, Japan, Taiwan, Mexico, Chile, and Australia. The catch has increased throughout the 1980's and 1990's (Fig. 18-4), averaging about 28,000 t in recent years (Table 18-1).

The stock structure and status of Pacific swordfish stocks are unclear. Several studies suggest more than one Pacific stock. The most recent assessment assumed a single Pacific stock and suggested that the stock was somewhat underutilized. However this assessment was limited to data through 1980. More recent statistics on catch and effort are not available, but as total catch has increased so has the crude estimate of LTPY. The RAY for 1988-90 exceeds the estimated LTPY (Table 18-1).

Since 1989, the U.S. domestic longline fishery for swordfish based in Hawaii has expanded rapidly to almost 5,000 t per year (Fig. 18-4), has ex-vessel revenue estimated at $24 million, and represents 15% of the total Pacific catch and 42% of the catch in the eastern central Pacific. The U.S. domestic harpoon and drift gillnet

. . . Swordfish

fishery off the west coast has declined since the mid-1980's (Fig 18-4), due in part to market competition from expanding fisheries in other areas. This fishery yields about $3.5 million in ex-vessel revenue annually.

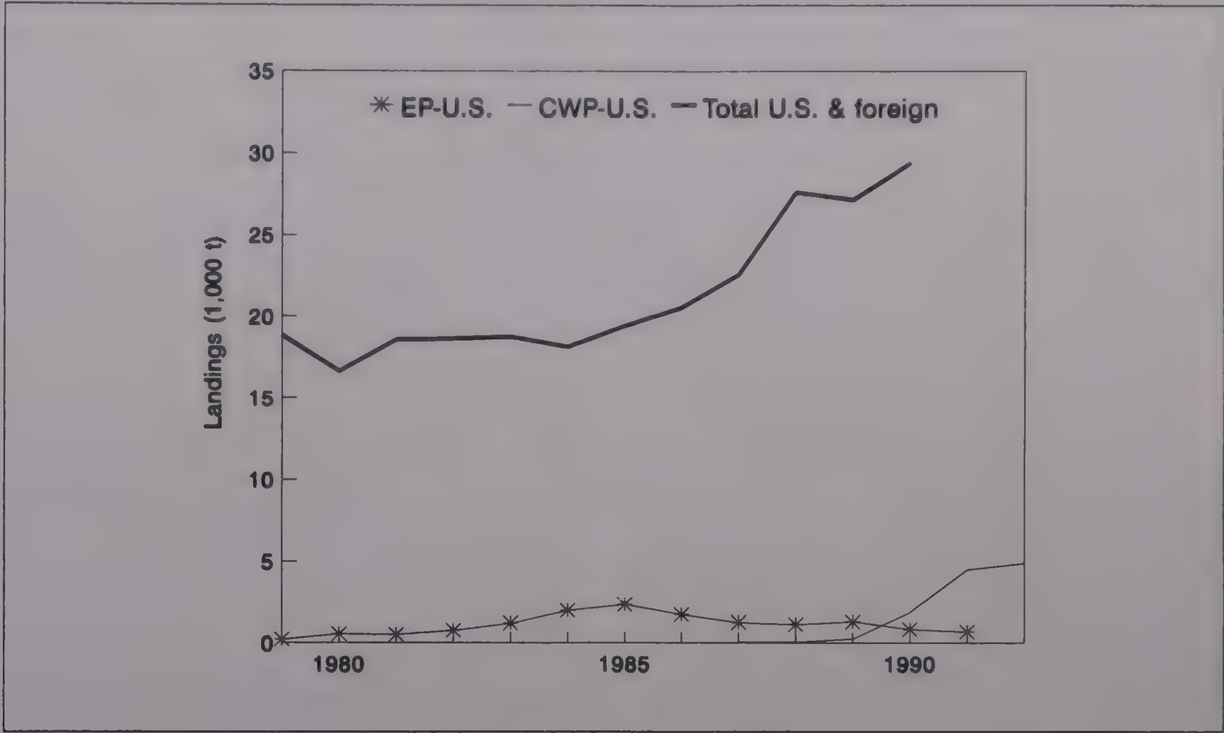


Figure 18-4.—Total U.S. and foreign landings of swordfish from the Pacific Ocean, 1979-90, and the U.S. landings from the eastern Pacific (EP), 1979-91, and the central-western Pacific (CWP), 1979-92.

Billfish and Other Species

Species included here are the blue, black, and striped marlins; sailfish, shortbill spearfish, wahoo, mahimahi (dolphin fish), and several oceanic sharks (requiem, thresher, hammerhead, and mackerel). They generally range from North America to Asia and between the North and South Pacific STCZ's. They are generally more abundant near islands, continental slopes, seamounts, and oceanic fronts, and many are important to local economies; they are caught by foreign and U.S. fishermen, both sport and commercial.

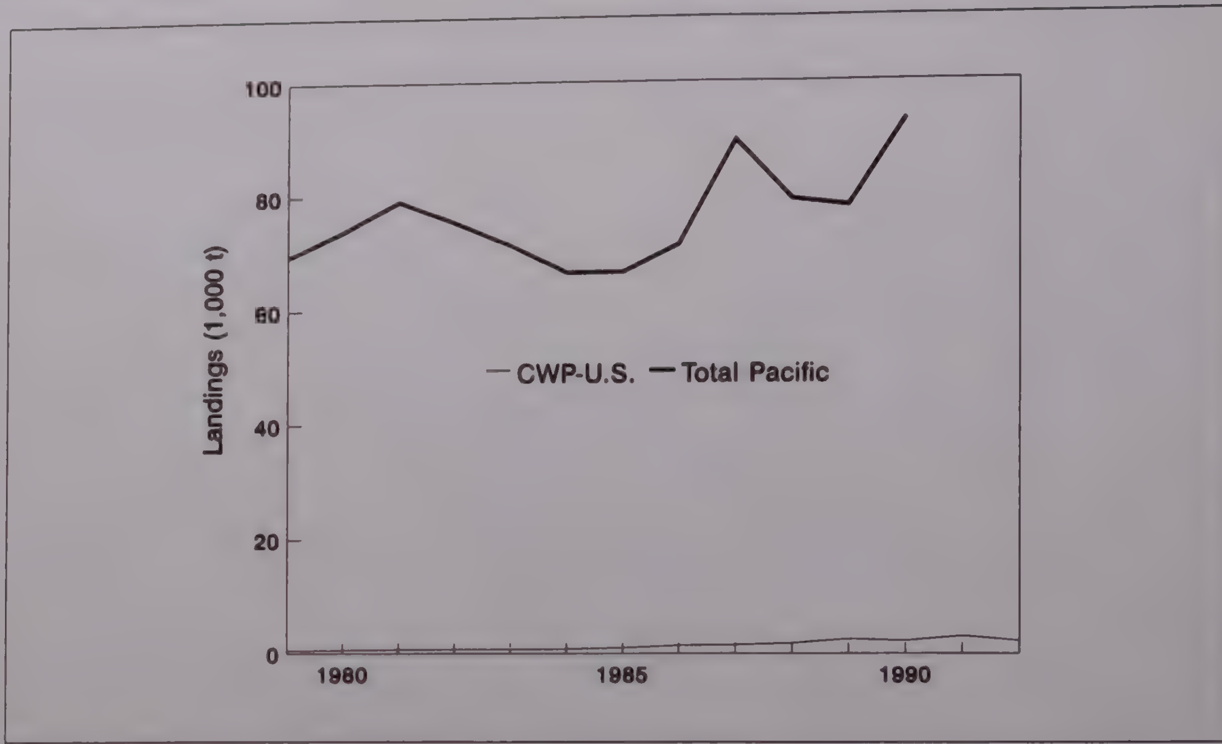
U.S. commercial fishermen in the western and central Pacific primarily use longline, troll, and handline gear to catch marlins, spearfish, wahoo, and mahimahi. Recreational fishing gears include rod-and-reel and handline. Sharks are taken by longline around the Hawaiian Islands and by harpoon and drift gillnet off North America.

Because of the many species in this "other species" category, no precise value can be calculated for the annual catch. However, the U.S. catch of blue and striped marlins is worth about $2,000/t ex-vessel, and the U.S. catch of wahoo and dolphin (mahimahi) is worth over $4,000/t.

Catches of these and other species (Fig. 18-4) have been relatively constant, between 66,000 and 93,000 t per year, with a slight increase in the most recent years. Three species dominate the reported catches of "other species": Blue and striped marlins and mahimahi. Pacific-wide shark catches in the "Carcharhinidae" and "requiem sharks" categories reported to the United Nations Food and Agriculture Organization total about 22,000 t per year, but pelagic shark catches are reported by only a few nations. The total Pacific harvest of pelagic sharks is unknown. Catches of "other species" by U.S. fisheries in the central and western Pacific increased steadily through the 1980's, leveling out in the 1990's, while catches by U.S. fisheries in the eastern Pacific have declined (Fig. 18-5).

The status of most species' stocks is unknown or uncertain. Assessments using data through 1985 indicated that striped marlin were utilized slightly below LTPY, and blue marlin was fished above LTPY; however, new data are needed to confirm or dispute these findings. The conditions of virtually all shark species remain unknown.

Figure 18-5.—Total U.S. and foreign landings of other pelagics (including billfish and sharks) from the Pacific Ocean, 1979-90, and the U.S. landings from the central-western Pacific (CWP), 1979-92.



ISSUES

Management Concerns

The primary issue for the management of Pacific tropical tunas is the lack of consensus on a comprehensive plan for gathering and reporting statistics and for setting up a conservation and management group to represent all interests. The lack of data is critical and prevents conducting accurate stock assessment, developing informed management options, and preparing pragmatic advice for rational exploitation of the resource.

Within the U.S. EEZ of the central and western Pacific, including Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, the Western Pacific Regional Fishery Management Council has developed, and the Secretary of Commerce has approved, a Fishery Management Plan (FMP) for pelagic species. The FMP specifically addresses concerns about the expanded Hawaii longline fleet and the potential for interactions among longliners, trollers, and handliners by placing a cap on the number of permits issued to longliners and establishing nearshore zones closed to longlining. At the Council's behest, NMFS implemented a mandatory logbook and reporting system in the region's domestic longline fleet to collect statistics for fishery monitoring. Research is underway to analyze the fishery statistics and evaluate the effectiveness of the longline fleet limits. A new concern is the possible impact of the expanded Hawaii fishery on the swordfish stock in the eastern and central Pacific, particularly if the expansion continues. The temporary cap on the number of Hawaii longline permits will expire in 1994 unless new controls are placed on effort by then. Proposed new controls may result in further expansion of the swordfish fishery by allowing the smaller longliners that previously fished for tuna in the closed nearshore zones to upgrade their vessels for offshore swordfish fishing.

High-seas drift gillnet fisheries had taken a dominant share of the North Pacific albacore catch until their elimination in 1993. The full impact of the driftnet gear on the stock is not yet clear; however, data from the fisheries are being collected and evaluated. In the South Pacific, the interaction between the established longline fishery and a rapidly growing surface fishery (predominantly U.S.) needs attention, particularly if allocation of available yield between the fisheries becomes an issue. The scope, structure, and organization of a multilateral management regime is another issue which needs attention.

The North Pacific albacore stock appears to be overutilized, possibly due to the long period of heavy catches by drift gillnets. Further data collection and an evaluation of the effects of the drift gillnet fishery and other factors, including environmental changes, are urgently

. . .Management Concerns

needed. Creation of an international forum to manage the stock is another issue that needs attention, particularly if the fishing nations want to reap the benefits of a recovered stock.

Our scientists recognize that at least one billfish species, the Indo-Pacific blue marlin is, and has been, depleted over its range, and no management mechanism exists to rebuild the stock. Similarly, thresher sharks taken in the west coast drift gillnet fishery may need protection from overexploitation.

The potential take of endangered Hawaiian monk seals and sea turtles was also a concern. The monk seal problem has been addressed by the Western Pacific Fishery Management Council through a strict prohibition of longlining within a 50-mile area surrounding the Northwest Hawaiian Islands. Sea turtle bycatch is being investigated further using data gathered by NMFS observers on longline vessels.

Scientific Advice and Adequacy of Assessments

Population levels of the billfishes and other species are either unknown or out of date: There is no international mechanism to collect fishery data on the Pacific-wide stocks, including those portions of the stocks that range in the U.S. EEZ. Basic biological data (beyond catches) are also lacking or grossly inadequate for most of these species. This limits determination of the current condition of the stocks. Bycatch of these species by drift gillnets and in other fisheries is another issue.

The impacts of the increased U.S. longline fleet in the Hawaiian EEZ and the central Pacific high seas on swordfish and other resources are unknown, but the catches are being monitored, and research is under way to better assess the stocks.

Progress

Research has been focused on selected issues, and progress has been made for several species, although, on the whole, the number of species/issues remains more than can be addressed given current agency resources.

For CWP yellowfin tuna, a series of informal international scientific meetings are under way to collect and organize needed statistics as a precursor for a comprehensive assessment. For North Pacific albacore, a multilateral management agreement has been proposed and is under review.

Management of the domestic fisheries has been successful in eliminating gear conflicts among longline, troll, and handline fisheries. Limited entry and area closures in the Hawaii longline fishery have stabilized or reduced the longline catch of tuna, marlin, and other pelagic species important to nearshore troll and handline fisheries, reducing the potential for fishery interaction. At the same time, the total yield of the Hawaii longline fishery has increased due to a change in targeting from tuna to swordfish.

UNIT 19 ALASKA GROUNDFISH FISHERIES

INTRODUCTION

The North Pacific Ocean (Fig. 19-1) is one of the most productive oceans, supporting many of the world's largest populations of groundfish, salmon, crabs, marine mammals, and seabirds. Large-scale commercial fisheries for groundfish in Alaska waters were developed and dominated by foreign fleets from the early 1950's until the Magnuson Fishery Conservation and Management Act (MFCMA) was passed in 1976. This act produced one of the great success stories for development of a U.S. groundfish industry. The Alaska groundfish fishery is now a major industry with total 1992 groundfish catches generating ex-vessel revenues of $658 million.

Though foreign fisheries dominated through 1983 (and were important through 1986), joint ventures and, later, domestic fishermen and processors fully replaced them.

Alaska's groundfish fisheries are managed by two fishery management plans: one for the Bering Sea/Aleutian Islands and the other for the Gulf of Alaska. Thus they are under constant watch by the North Pacific Fishery Management Council. The Pacific halibut is managed under treaty between the United States and Canada, and primary assessment and management recommendations are provided by the International Pacific Halibut Commission.

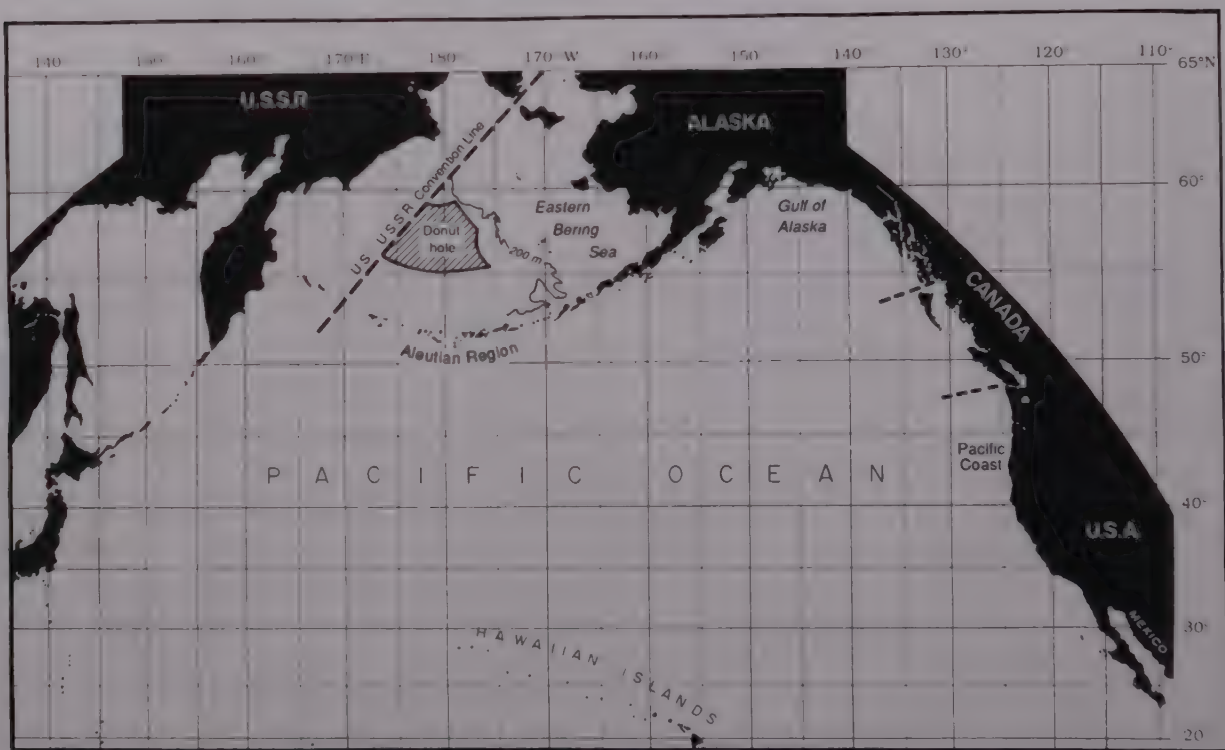


Figure 19-1.—The North Pacific Ocean.

SPECIES AND STATUS

Pacific Halibut

Halibut is found from the Bering Sea to Oregon, though the center of abundance is in the Gulf of Alaska. The resource is considered as one large interrelated stock but is regulated by subareas with catch quotas and time-area closures. The fishery has a long tradition extending back to the late 1800's. There is an active recreational fishery as well.

The total 1991 Pacific halibut catch was 34,381 t, worth $110.5 million dockside. In 1992, 35,700 t of Pacific halibut were landed commercially (31,100 t in the United States and 4,700 t in Canada) (Fig. 19-2) worth $71.2 million. Other catches were 4,000 t taken in the recreational fishery, unreported catch of 650 t taken for personal use, wasted mortality of 1,450 t due to fishing by lost gear and discard, and incidental catch mortality of 9,260 t by fishermen targeting other species. About 6,273 U.S. vessels were licensed for the commercial halibut fishery, as were 435 Canadian vessels. Not all U.S.-licensed vessels fished.

The exploitable portion of the Pacific halibut stocks apparently peaked at 200,000 t in 1986-88 (Fig. 19-2). The population has since declined at about 5%/year. Some decline is still expected, but halibut numbers are still fairly high by historical standards. The species is fully utilized (Table 19-1).

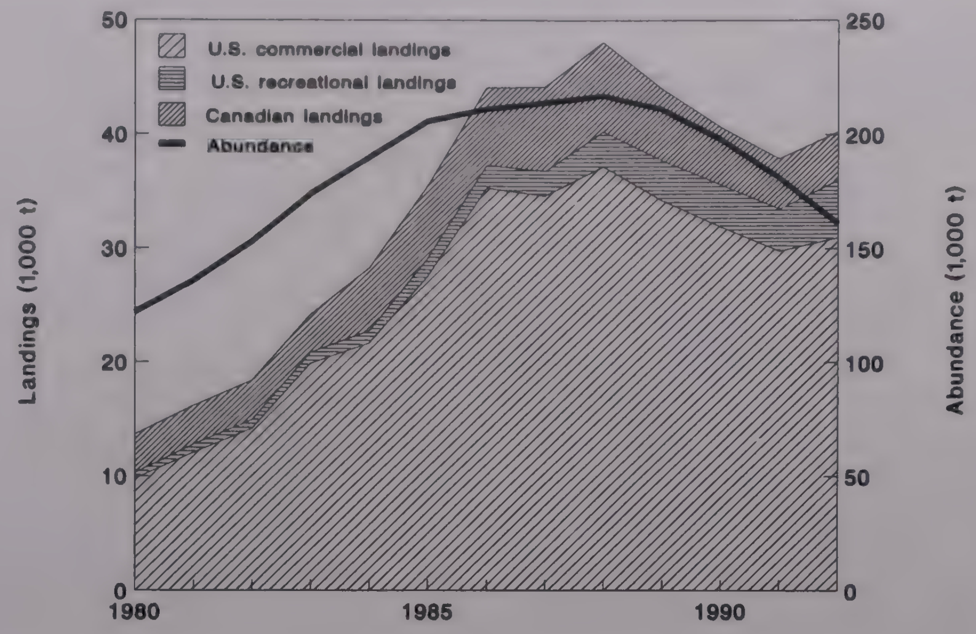


Figure 19-2.—Landings and abundance trends for Pacific halibut in the North Pacific Ocean for U.S. commercial and recreational fisheries and the Canadian fishery, 1980-92.

Table 19-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for Pacific halibut. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY)[1] =	20,000 t	(17,300 t, U.S. only)
Current potential yield (CPY)[1] =	33,500 t	(29,000 t)
Recent average yield (RAY)[2] =	35,700 t	(31,000 t)

Region	Yield (t) RAY[2]	CPY[1]	LTPY[1]	Status of utilization	Status of stock level
Bering Sea-Aleutian Islands	3,600	2,800	1,700	Full	Near
Gulf of Alaska	27,200	25,900	15,400	Full	Near
Off Pacific coast[3]	200	300	200	Full	Near
Off Canadian Pacific coast	4,700	4,500	2,700	Full	Near

[1]Does not include 16,000 t for sport catch, bycatch, and waste.
[2]1989-92 average.
[3]California, Oregon, and Washington.

Bering Sea-Aleutian Islands Groundfish

The average Eastern Bering Sea-Aleutian Islands groundfish catch during 1990-92 was about 1.66 million t (Table 19-2; Fig. 19-3). The total catch in 1992 was 1.76 million t, valued at $522 million (ex-vessel). The dominant species harvested were walleye pollock (1.4 million t valued at $355 million); Pacific cod (164,000 t valued at $82 million), and yellowfin sole (106,000 t valued at $13.6 million).

Groundfish populations have been maintained at high levels since implementation of the MFCMA. Their long-term potential yield (LTPY) is about 3.00 million t. The current potential yield (CPY) of 2.42 million t for 1992 is slightly below LTPY. This potential, however, has not been fully utilized because catch quotas cannot exceed the optimum yield (OY) set by the FMP at 2.0 million t out of consideration for both socioeconomic and biological factors.

Walleye Pollock: Pollock produce the largest catch of any single species inhabiting the U.S. EEZ. The three main stocks, in decreasing order of abundance, are: Eastern Bering Sea (EBS) stock, Aleutian Basin (AB) stock, and the Aleutian Islands (AI) stock. The EBS stock is still moderately high (near the level that produces LTPY) and is now fully utilized. The AI stock is believed to be in the same condition as the EBS stock.

Another large pollock fishery lies outside the U.S. and Russian EEZ's in the "Donut hole" of the central Bering Sea (Fig. 19-1). This fishery was dominated by Japan, the former Soviet Union, Poland, China, and the Republic of Korea. They target the AB pollock stock during its migration through the donut hole area. Historical catches

Figure 19-3.—Landings and abundance trends for groundfish resources in the Bering Sea/Aleutian Islands region for the foreign, joint-venture, and U.S. fisheries, 1976-92.

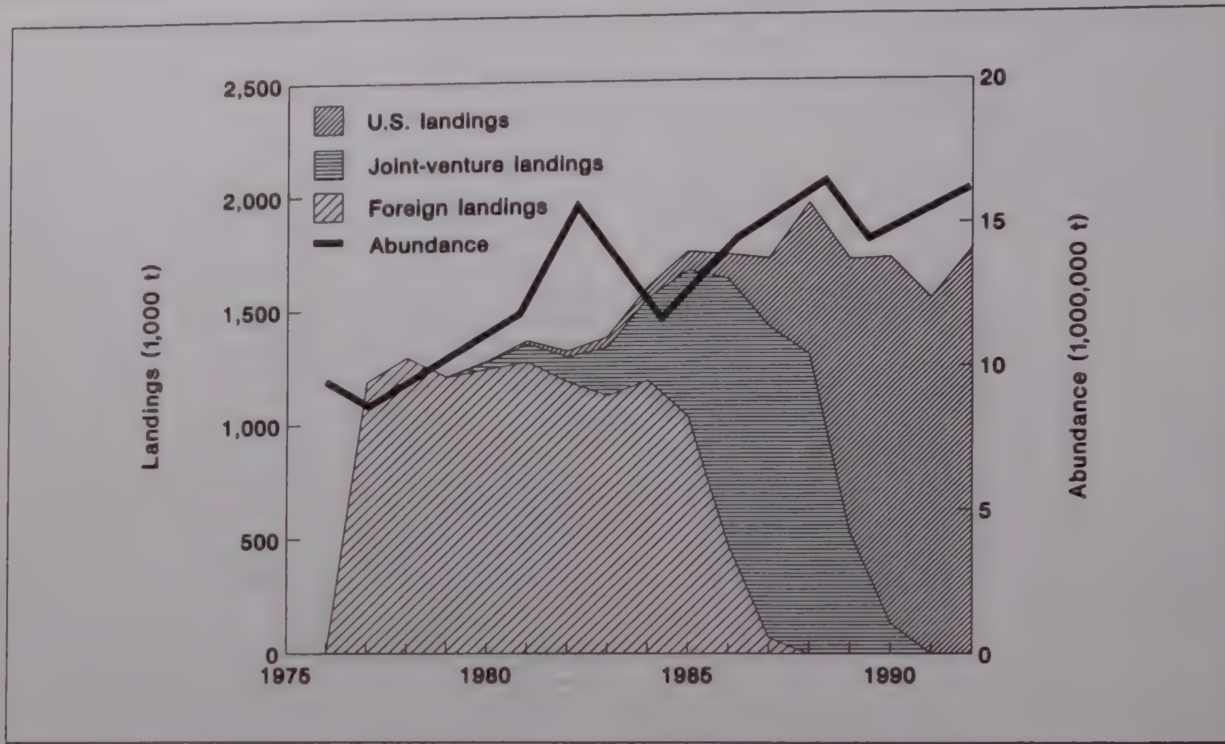


Table 19-2.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Bering Sea-Aleutian Islands groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum.

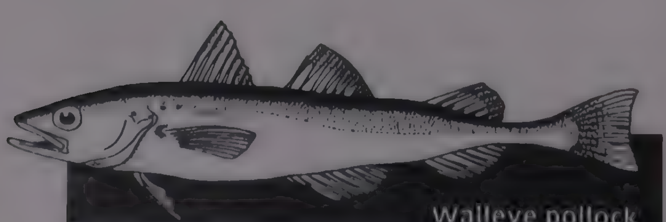
Long-term potential yield (LTPY) = 2,903,923 t
Current potential yield (CPY) = 2,423,298 t
Recent average yield (RAY)[1] = 1,664,710 t

Species	Yield (t) RAY1	CPY	LTPY	Status of utilization	Status of stock level
Walleye pollock	1,281,000	1,398,700	1,944,600	Full	Near
Pacific cod	170,300	164,500	143,000	Full	Near
Yellowfin sole	90,400	238,000	220,000	Full	Near
Greenland turbot	5,800	7,000	27,100	Full	Below
Arrowtooth flounder	5,600	72,000	59,000	Under	Above
Rock sole	29,900	185,000	160,200	Under	Above
Other flatfish	12,100	191,000	148,500	Under	Above
Sablefish	3,270	4,903	5,323	Full	Near
Pacific ocean perch	14,500	17,170	14,900	Full	Near
Other rockfish	930	1,325	1,300	Full	Near
Atka mackerel	30,260	117,100	117,100	Full	Above
Other fish	20,650	26,600	62,900	Under	Above

[1]1990-92 average.

. . . Bering Sea-Aleutian Islands Groundfish

from this stock were apparently too high and not sustainable. The abundance of the AB stock is now extremely low, and all the fishing nations agreed to cease fishing in the donut hole area for 1993 and 1994. The 1992 catch was negligible when compared to the peak catch of 1.45 million t in 1989.



Walleye pollock
Theragra chalcogramma

Pacific Cod: Pacific cod abundance remained fairly high and stable throughout the 1980's. However, the stock has been declining since about 1990. This decline and poor recruitment over the past few years may be due to changing environmental conditions or ecological relationships. The cod stock is fully utilized.

Flatfishes: Yellowfin sole is the most abundant of the flatfishes. During the 1950's, yellowfin sole was the major trawling target, but it now ranks behind both pollock and Pacific cod. Yellowfin sole is fully utilized. Greenland turbot, the only

... Bering Sea-Aleutian Islands Groundfish

depressed flatfish stock, is expected to decline further during the mid-1990's owing to poor spawning success in the 1980's. It is fully utilized.

All other flatfish species are in good-to-excellent condition. Populations continue to be high and increasing for arrowtooth flounder and high and stable for rock sole, flathead sole, Alaska plaice, and other flatfishes. The rock sole is now the second-most abundant of the flatfishes, increasing substantially from 1980. It is underutilized, as are most other flatfishes. Their catches have been restricted to prevent excessive incidental catches of Pacific halibut and king and Tanner crabs.

Sablefish: Sablefish or blackcod is a valuable species caught mostly with longline and pot gear below the depths fished by trawlers. Sablefish is considered to be a single stock from the Bering Sea-Aleutian Islands (BSAI) region to the Gulf of Alaska. The BSAI population declined substantially in 1990, partly due to migration into the Gulf of Alaska. Current abundance is low to average, and recruitment has been relatively weak. Sablefish is fully utilized.

Rockfishes: Rockfishes are assessed and managed as two major groups: Pacific ocean perch (POP) and "other rockfish." POP abundance dropped sharply owing to intensive foreign fisheries in the 1960's and remained low into the early 1980's. In recent years, catch levels have been set well below CPY to help rebuild the stocks. The POP group is now recovering and is considered fully utilized.

The "other rockfish" group includes two thornyhead species and about 30 other rockfish species not included in the POP group. Little is known about them, but they are considered fully utilized.

Atka Mackerel: The Atka mackerel stock occurs mainly in the Aleutian Islands region. Previously, CPY for this species had been set conservatively low because of uncertainty regarding its abundance. However, trawl surveys conducted by NMFS in 1986 and 1991 have confirmed a higher abundance of the stock than previously believed, and its CPY for 1992 and 1993 have been raised. The stock is considered fully utilized.

Other Species: In recent years, "other species" catches have represented 1% or less of the total groundfish catch. Sculpins and skates probably constitute most of this resource, but the abundance of pelagic squids, smelts, and sharks is largely unknown. The CPY has been set at the average catch level.

Gulf of Alaska Groundfish

Groundfish abundance in the Gulf of Alaska has been relatively stable, rising slowly from 1984. The estimated LTPY for Gulf of Alaska groundfish is 451,377 t (Table 19-3). The CPY is 735,507 t which reflects higher than normal abundance of the stocks. The RAY is 225,170 t. The wide disparity between the CPY and the RAY is because groundfish fishing is restricted by the NPFMC to reduce incidental catches of Pacific halibut.

Gulf of Alaska groundfish catches have ranged from a low of 135,400 t in 1978 to a high of 352,800 t in 1984 (Fig. 19-4), with pollock dominant, followed by Pacific cod and sablefish. The 1992 groundfish catches of 213,000 t were valued at $136 million (ex-vessel revenue). Sablefish comprised about 34% ($46.1 million) of the total Gulf value. Other major revenue-producing species that year were Pacific cod ($38.3 million), pollock ($26.6 million), and rockfishes ($12.9 million).

Pollock and Pacific Cod: Pollock numbers appear to be recovering after a few years of low abundance. It is fully utilized. Pacific cod are abundant and fully utilized, but are expected to decline. Reproduction has not kept pace with natural and fishing losses.

Flatfish, Sablefish, and Rockfish: Flatfish are in general very abundant, largely owing to great increases in arrowtooth flounder. Flatfish are managed as deep-water and shallow-water groups, while flathead sole and arrowtooth flounder are managed as separate categories.

Sablefish are still fairly abundant, though they are projected to decline due to low recruitment. They are fully utilized.

"Slope" rockfish are at low levels and are fully utilized. They grow slowly, are long-lived, and have not rebounded from the heavy foreign fishing in the 1960's. The principal species in this group, Pacific ocean perch, shortraker rockfish, and

. . . Gulf of Alaska Groundfish

rougheye rockfish, are highly valued. They are in a separate management category. Thornyhead rockfishes are also believed to be at a low level and decreasing. The abundance of continental shelf rockfishes (pelagic and demersal) is unknown and needs further research.

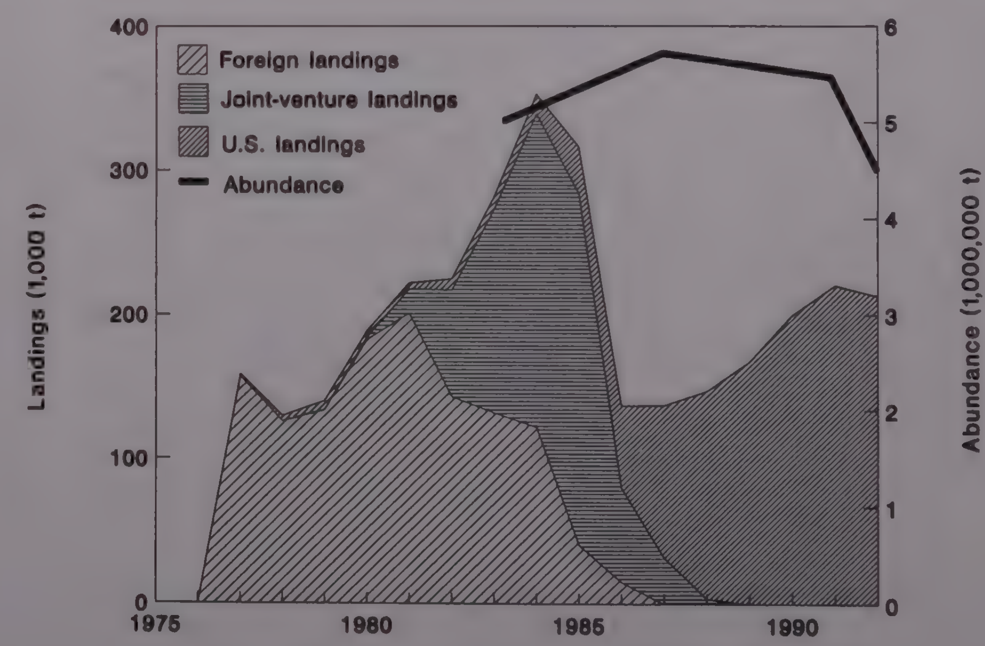
Table 19-3.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Gulf of Alaska groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 451,377 t
Current potential yield (CPY) = 735,507 t
Recent average yield (RAY)[1] = 225,120 t

Species	Yield (t)			Status of	Status of
	RAY[1]	CPY	LTPY	utilization	stock level
Walleye pollock	81,400	160,000	169,000	Full	Below
Pacific cod	76,680	56,700	56,700	Full	Above
Flatfish	21,160	466,750	169,000	Under	Above
Sablefish	24,370	23,937	25,987	Full	Near
Slope rockfish	17,010	19,400	Unknown	Full	Below
Thornyhead rockfish	1,500	1,180	3,750	Unknown	Below
Pelagic shelf rockfish	2,530	6,740	Unknown	Under	Unknown
Demersal shelf rockfish	470	800	800	Full	Unknown

[1]1990-92 average.

Figure 19-4.—Landings and abundance trends for groundfish resources in the Gulf of Alaska region for the foreign, joint-venture, and U.S. fisheries, 1976-92.



ISSUES

Transboundary Stocks and Jurisdiction

Large unregulated foreign pollock fisheries in the "Donut hole" of the Bering Sea (Fig. 19-1) were a major U.S. concern as they targeted the migrating U.S. (and Russian) stocks outside the U.S. EEZ. Another concern is the lack of data to determine the status of the stocks. Several international meetings have been organized to develop cooperative research and management of the fishery. The user countries have now begun to cooperate on research and reached agreement to cease fishing in the donut hole area for 1993 and 1994 due to extreme low abundance of the Aleutian Basin pollock stock.

Bycatch and Multispecies Interactions

Marine mammal interactions with fish and fisheries are a growing concern. Steller sea lions are listed as threatened under the Endangered Species Act, and groundfish fisheries have been modified to reduce impact on them. Pollock provide food for sea lions, and some fisheries have occurred near rookeries; however, there is lack of data to show a direct cause-and-effect relationship between the pollock fishery and the decline of the sea lions.

The incidental catch of Pacific halibut and king and Tanner (snow) crabs off Alaska now curtails expansion of the groundfish fisheries. When halibut and crab bycatch limits are reached, the groundfish fisheries get closed down, usually before harvesting the entire groundfish quotas. Various incentive programs are being tested to control bycatches while improving the groundfish harvest. The latest program is an individual vessel incentive program whereby bycatch rates are established for the fleet and tracked by individual vessels. This program is designed to give a vessel more control over its total fishing time by controlling its own bycatch rates.

Bycatches of chinook and "other" (mostly chum) salmon continue to be a significant problem in the Bering Sea/ Aleutian Islands and Gulf of Alaska management areas. While no regulations other than trawl fishing season delays have yet been promulgated to reduce salmon bycatch, the NPFMC is reviewing potential measures that could further constrain groundfish trawl fishing in the future.

Progress

Large unregulated foreign pollock fisheries in the "donut hole" of the central Bering Sea remain a major concern to the U.S. as these fisheries are capable of targeting U.S. pollock stocks during their migration outside the U.S. EEZ. Seven international conferences have been held through June 1993 to develop an international agreement for management of the straddling stocks. To date, agreement has been reached to conduct cooperative research on the stocks and to cease pollock fishing in the donut hole area for 1993 and 1994. A longer term agreement for management of the fisheries remains to be concluded.

As the domestic groundfish fisheries are now fully developed and rapidly over-capitalized, allocation disputes between user groups have been exacerbated. These problems include inshore vs. offshore, fixed gear vs. trawler, and other user conflict issues. The NPFMC has been addressing the problems as they arise and developing FMP amendments to mitigate them. Recent FMP amendments have been implemented that have made explicit allocations to inshore and offshore sectors of the industry as well as percentage allocation of harvest amounts to specific gear types.

NMFS has promulgated regulations to implement an Individual Fishing Quota (IFQ) program for sablefish and Pacific halibut. Under the IFQ program, vessel owners will be allocated transferrable quota shares of sablefish and halibut. Fishing under this program is scheduled to begin early in 1995.

Bycatch of nontarget species and adverse interactions with marine mammal populations by the groundfish fisheries are continuing problems for the NPFMC. These problems have been mitigated via a combination of regulations that control bycatch limits and time-area closures, and institute protection of special northern sea lion rookery areas. The NPFMC is also testing an incentive program to control bycatch while improving the groundfish harvest. This is an individual vessel incentive program whereby bycatch rates are established for the fleet and regulated by individual vessels. It is designed to give a vessel more control over its own fishing destiny by holding it directly accountable for its bycatch rates.

INTRODUCTION

Alaska shellfish catches generated ex-vessel revenues of about $318.7 million in 1992. King and Tanner crab fisheries are currently the most important shellfish fisheries at $305 million. Shrimp resources contributed only about $687,000; their present abundance is too low for significant commercial utilization at this time. There is a fairly large sea snail resource waiting to be utilized that may add a few million dollars to the revenue total. Alaska also harvests the following invertebrate resources, mostly within State waters: Dungeness crab, Korean horsehair crab, sea cucumbers, sea urchins, scallop, abalone, geoduck clam, and octopus. The ex-vessel revenue received for these landings (4,340 t) was $13 million in 1992. The first major domestic king crab fishery off Alaska began in the 1960's off Kodiak Island, later expanding to the Aleutian Islands and Bering Sea.

The king and Tanner crab fisheries are managed primarily by the State of Alaska with advice from a Federal FMP for the Bering Sea and Aleutian Island stocks. The snail fishery is managed by a Federal Preliminary Fishery Management Plan (PFMP). Shrimp fisheries and the near-shore rsources are managed by the State of Alaska.

SPECIES AND STATUS

Crab

Three species of king crabs (red, blue, and golden or brown) and two species of Tanner crabs (*Chionoecetes bairdi* and *C. opilio*) are harvested commercially off Alaska. Values for RAY, CPY, and LTPY are presented in Table 20-1. Information on CPY and LTPY is lacking for king and Tanner crabs; thus default values were derived from historical average catches. Alaska crabs are all fully utilized. The RAY of king crabs during 1989-91 of 12,710 t has been below the LTPY of 27,070 t. By contrast, RAY for Tanner crabs of 112,510 t during 1989-91 has been above LTPY of 40,900 t.

The annual dockside revenue for Alaska king crabs (about 12,000 t) and Tanner crabs (about 157,470 t) in 1992 was $305 million; 26% ($79 million) was attributable to king crabs and the rest to Tanner crabs. Almost all (99%) of the Tanner crab production came from the Bering Sea, where *C. opilio* comprised 54% of the value. Virtually all king crab landings came from the Bering Sea/Aleutian Islands (BSAI). Red king crab made up 66% and brown king crab contributed 23% of the landed value.

About 350 vessels make up the BSAI crab fleet. Over 400 vessels harvest crabs in the Gulf of Alaska, although there was considerable vessel overlap between the areas. Catches are restricted by quotas, seasons, and size and sex limits. Fishing seasons are set at times which avoid molting, mating, and softshell periods, both to protect crab resources and to improve product quality. Only male crabs are permitted to be harvested.

Catch and abundance trends for king crabs are shown in Fig. 20-1. After a 1964-66 peak, declines were evident. Until 1967, Japanese and former Soviet Union fisheries dominated Bering Sea landings, but those fisheries were phased out by 1974. In the Bering Sea, domestic catches peaked at 74,000 t in 1980, dropped precipitously in 1981, and hit a low in 1983.

Table 20-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Alaska shellfish resources. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 95,370 t
Current potential yield (CPY) = 127,320 t
Recent average yield (RAY)[1] = 127,051 t

Species group	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Tanner crabs	112,510	112,510	40,900	Full	Above
King crabs	12,710	12,710	27,070	Full	Below
Shrimp	0	300	22,600	Full	Below
Snails[2]	1,831	1,800	4,800	Under	Unknown

[1] 1989-91 average.
[2] RAY and CPY data = 1985-87 average catch; LTPY data = 1971-87 average.

. . . Crab

Since then, there has been a slight gradual increase in the catch. Gulf catches varied at a relatively low level for a decade before dropping lower yet in 1983. Almost all Gulf of Alaska king crab fisheries have been closed since 1983.

Tanner crab catches are largest in the eastern Bering Sea (Fig. 20-2). The 1965-75 period was a developmental phase. During 1975-85, the catch peaked at about 49,000 t in 1979 and then declined. Since 1984, the catch has increased, reaching about 163,500 t in 1991. Abundance trends for the eastern Bering Sea stocks indicate that the *C. bairdi* stock declined from a relatively high level in the late 1970's to a low in 1985. Since then, the Bering Sea *C. bairdi* stock has recovered and is currently approaching its former level. From a low in 1985, the *C. opilio* stock has rebounded sharply and is approaching an all-time high level. The catch in the Gulf of Alaska, composed exclusively of *C. bairdi*, reached peak levels during the 1970's, following a developmental phase in the late 1960's. Since 1979, the Gulf of Alaska catch has declined.

Figure 20-1.—King crab landings and abundance for the Bering Sea and Gulf of Alaska, 1960-91.

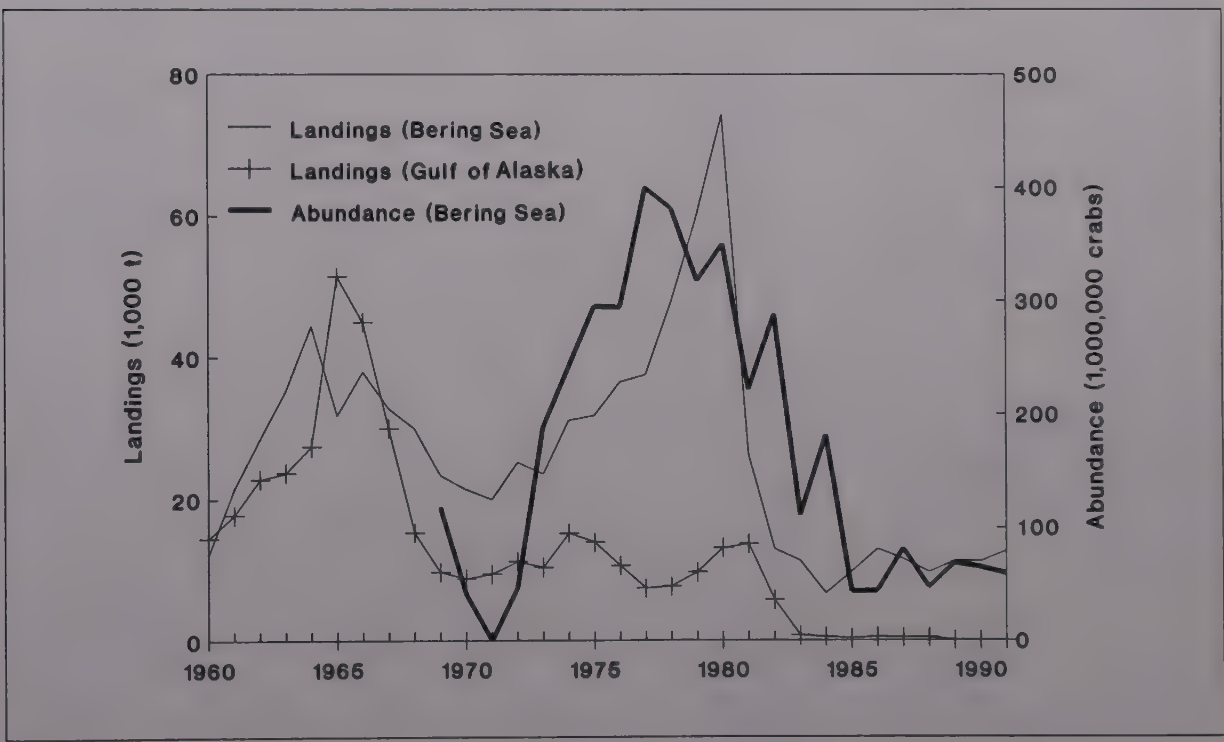
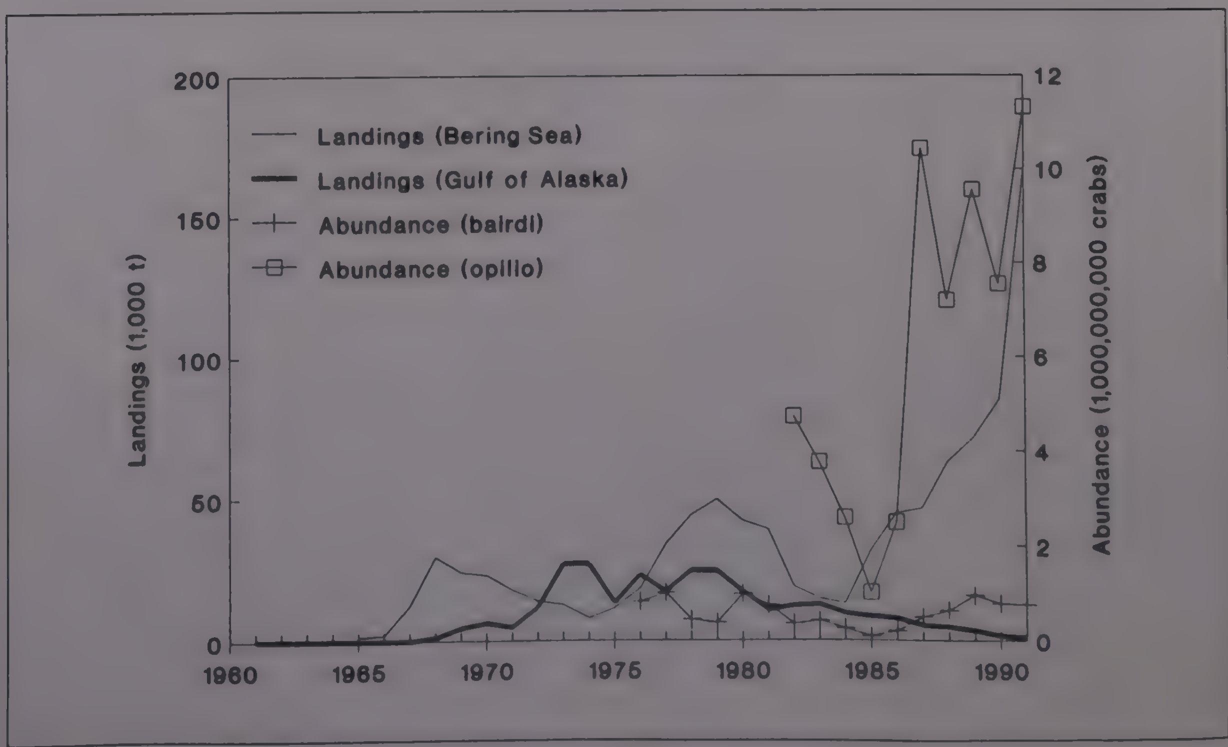


Figure 20-2.—Tanner crab landings and abundance from the Bering Sea and Gulf of Alaska, 1961-91, and abundance of two species of Tanner crab, 1976-91.



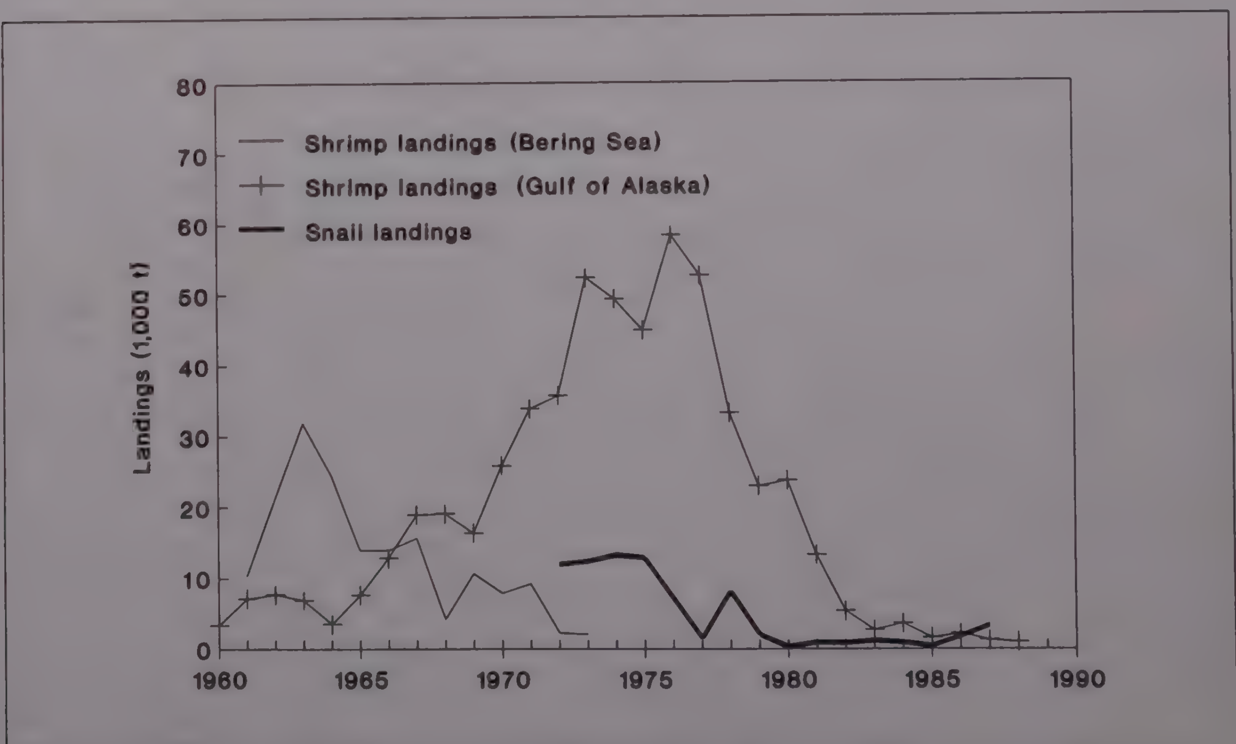
Shrimp and Sea Snail

Five species of shrimp contribute substantially to Alaska landings, of which the northern pink shrimp is most important. The U.S. fishery for shrimp in Alaska waters is currently at a low level. The 1992 catch in the Gulf of Alaska was only 900 t, and generated an ex-vessel revenue of about $680,000. Shrimp abundance is too low in the Bering Sea to support a commercial fishery. The western Gulf of Alaska has been the main area of operation. During the 1970's, when the fishery was more productive, 50-100 vessels trawled for shrimp at Kodiak and along the Alaska Peninsula.

Shrimp landings in the Gulf of Alaska during 1960-90 (Fig. 20-3) show that catches rose steadily to about 58,000 t in 1976 and then declined precipitously. Since 1988, negligible amounts of shrimp have been landed. During 1960-90, the dockside ex-vessel revenue from the western shrimp fisheries averaged $4 million annually and yielded a peak revenue of $14 million in 1977. Shrimp catches by the former Soviet Union and Japan in the Bering Sea peaked at 32,000 t in 1963, and declined gradually thereafter, until the fishery ended in 1973. As with crabs, the potential yields of Alaska shrimp stocks are not well understood, and they have been equated to recent catches. Shrimp are managed by regulating the catch levels according to the level of the stocks. In addition, spring "egg hatch" closures are used to protect breeding stocks.

The Japanese fishery for snails, conducted from about 1971 until ending in 1987, reached a peak of some 13,000 t in 1974. Catches averaged about 4,800 t during 1971-87. The snail stocks of the Bering Sea are underutilized because they are currently not fished. RAY and CPY equal the 1985-87 average catch and LTPY equals the 1971-87 average.

Figure 20-3.—Shrimp landings from the Bering Sea and Gulf of Alaska, 1960-88, and snail landings from the Bering Sea, 1972-87.



ISSUES

Bycatch

The bycatch of crabs in trawl and pot fisheries is a major issue. Not only is bycatch an allocation problem, the unknown mortalities associated with trawl and pot gear discards of crabs could have a biological impact on crab stocks. When crab numbers are low, such bycatch mortalities, coupled with directed fishing mortality, could impose unacceptable risks to stock recovery. Bycatch limits for king and Tanner crabs have been placed on groundfish fisheries by the NPFMC.

INTRODUCTION

Many U.S. coastal and estuarine species provide important recreational and commercial fisheries that are not Federally managed. This diverse Unit includes highly prized gamefishes like tarpon, bonefish, permit, and snook, as well as tautog, surfperches, and Florida pompano. It also includes small fishes used for bait, food, or processing into oil and meal, such as mullet, smelts, eulachon, ballyhoo, sardines, and herrings. Valuable invertebrates like the Dungeness, blue, rock, and Jonah crabs; Pacific shrimps, abalones, hard and softshell clams, bay scallops, and oysters are also in this group.

For 1990-92, the average annual dockside revenue from the commercial components of the fisheries in Table 21-1 was about $389 million. No separate values are available for the recreational fisheries, but they are certainly significant, especially to many coastal economies.

Table 21-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for nearshore fisheries resources. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY)[1] = Unknown
Current potential yield (CPY)[1] = Unknown
Recent average yield (RAY)[2] = 221,683 t

Species	Yield (t) RAY[2]	CPY	LTPY	Status of utilization	Status of stock level
Blue crab	93,313[3]	Unknown	Unknown	Full	Near
Pacific shrimp	28,466[3]	Unknown	Unknown	Full	Unknown
Sea urchins (Pacific)	22,144[3]	Unknown	Unknown	Unknown	Unknown
Dungeness crab	14,439[3]	Unknown	Unknown	Full	Near
Mullets	13,536	Unknown	Unknown	Unknown	Unknown
Oyster (Atlantic)	11,147[3]	Unknown	Unknown	Over	Below
Sea urchins (Atlantic)	8,575[3]	Unknown	Unknown	Unknown	Unknown
Atlantic hard clams	4,720[3]	Unknown	Unknown	Over	Below
Atlantic thread herring	3,788	Unknown	Unknown	Unknown	Unknown
Oyster (Pacific)	3,674[3]	Unknown	Unknown	Unknown	Unknown
Blue mussel	3,530[3]	Unknown	Unknown	Unknown	Near
Ladyfish	2,118	Unknown	Unknown	Unknown	Unknown
Softshell clam	2,106[3]	Unknown	Unknown	Full	Below
Tautog	1,880	Unknown	Unknown	Unknown	Unknown
Other shads, herrings	1,876	Unknown	Unknown	Over	Below
Eulachon	1,290[3]	Unknown	Unknown	Unknown	Below
Spanish sardine	1,068	Unknown	Unknown	Unknown	Unknown
Jonah crab	791[3]	Unknown	Unknown	Unknown	Unknown
Rock crab	538[3]	Unknown	Unknown	Unknown	Unknown
Ballyhoo	501[3]	Unknown	Unknown	Unknown	Unknown
American eel	486	Unknown	Unknown	Unknown	Unknown
Pacific hard clams	441[3]	Unknown	Unknown	Full	Below
Surfperches	335	Unknown	Unknown	Unknown	Unknown
Calico scallop	238[4]	Unknown	Unknown	Over	Below
Snook	219[3]	Unknown	Unknown	Full	Unknown
Bay scallop	202[3]	Unknown	Unknown	Over	Below
Florida pompano	127	Unknown	Unknown	Unknown	Unknown
Abalones	69[3]	Unknown	Unknown	Over	Below
Surf smelt	30	Unknown	Unknown	Unknown	Unknown
Permit	26[4]	Unknown	Unknown	Unknown	Unknown
California corbina	10[4]	Unknown	Unknown	Over	Below
Tarpon	Unknown[5]	Unknown	Unknown	Unknown	Unknown
Bonefish	Unknown[5]	Unknown	Unknown	Unknown	Unknown
Striped bass (Pacific)	Unknown[5]	Unknown	Unknown	Over	Below
Pacific razor clam	Unknown[6]	Unknown	Unknown	Over	Below
Pismo clam	Unknown[6]	Unknown	Unknown	Over	Below

[1]For accounting purposes in the National Overview tables and figures, RAY was substituted for LTPY and CPY.

[2]Based on 1990-92 average landings or most recent 3-year average. Recent value of commercial landings = $388.9 million (recent recreational participation is unknown).

[3]Commercial landings only.

[4]Recreational landings only.

[5]Not available or not meaningful due to catch-and-release nature of fishery or relatively infrequent landings

[6]Not available.

SPECIES AND STATUS

Most species in this group (Table 21-1) live near shore during much or all of their lives. Some, like the shads, herrings, smelts, and the striped bass, are anadromous, ascending fresh water to spawn but spending their adult lives in estuaries or at sea. In contrast, the American eel lives much of its life in fresh or brackish water but migrates far offshore to spawn in the Sargasso Sea (deep Atlantic, beyond the Gulf Stream, off the U.S. southeast).

These species are widely distributed. Bay scallops, hard and softshell clams, and rock and Jonah crabs are among the important fishery resources of the northeastern United States. Shads, herrings, sardines, mullets, Florida pompano, and calico scallops are fished primarily along the middle and southern U.S. Atlantic coast and in the Gulf of Mexico. Many of the gamefishes are particularly valuable to the Florida economy, while invertebrates, like the blue crab and Atlantic oyster, support major fisheries from the Gulf to Chesapeake Bay.

Corvina and striped bass are important sport fishes in California waters, while surfperches are fished along much of the U.S. west coast. Other species like abalones, clams (hard, Pismo, razor), eulachon, and surf smelt support both recreational and commercial west coast fisheries. In the Pacific Northwest and southern Alaska, Dungeness crabs, oysters, and shrimps support valuable commercial fisheries.

Bonefish, tarpon, snook, and permit are sought primarily by sport fishermen who often employ professional guides. Other popular recreational fishes, such as the surfperches and tautog, are caught primarily from the beach or small boats. The small baitfishes and food fishes are harvested by both recreational and commercial fishermen using cast nets, gill nets, seines, dip nets, and pound nets; the southern Florida ballyhoo fishery supplies bait to the charterboat industry.

Many methods are also used to harvest the invertebrate species. Commercial and sport divers gather abalones, particularly off southern and central California; fishermen in small boats dive, dredge, and tong for oysters and rake hard clams; recreational clammers dig Pismo clams on sandy beaches in central California and razor clams in the Pacific Northwest; trawlers and divers take sea urchins off the New England and northern Pacific coasts; and commercial and recreational crabbers fish with pots, traps, trotlines, dredges, and dip nets for blue, rock, and Jonah crabs on the Atlantic coast and for Dungeness crabs on the Pacific coast. Pacific shrimps are harvested with pots and trawls. Other species, such as blue mussels, are both cultured and harvested from the wild.

The number of participants in these nearshore fisheries is difficult to assess because of their diversity. There is no doubt, however, that millions of recreational and commercial fishermen seek these resources; there are, for example, an estimated 600,000+ recreational razor clam diggers in Washington alone.

In general, landings for many of these species have declined in recent years (Fig. 21-1, 21-2, 21-3, 21-4). Atlantic hard clam, softshell clam, bay scallop, and abalone landings were substantially lower in the 1980's than in the previous three decades. Atlantic oyster landings fell sharply in the late 1980's, and Chesapeake Bay stocks are considered severely depleted. After peaking in the 1970's, Pacific shrimp landings fell off in the 1980's, primarily because of reduced Alaska landings. Dungeness and blue crab landings, though cyclical, appear to have withstood harvesting pressures well through the 40-year period examined.

Because these species frequent nearshore waters, they are not included in Federal fishery management plans; some are managed under regional, state, and/or local authority. Typically, size limits are used to protect molluscan and crustacean resources from overutilization, whereas gear restrictions are the most common management measures used for the finfishes in this group. Area closures, bag limits, and catch quotas are also employed, particularly for shellfish. Interstate Fishery Management Commission plans have been developed for such Chesapeake Bay species as the oyster and blue crab to try to achieve consistent management between states. Some states, notably Florida and California, have prohibited all commercial harvest of certain species by designating

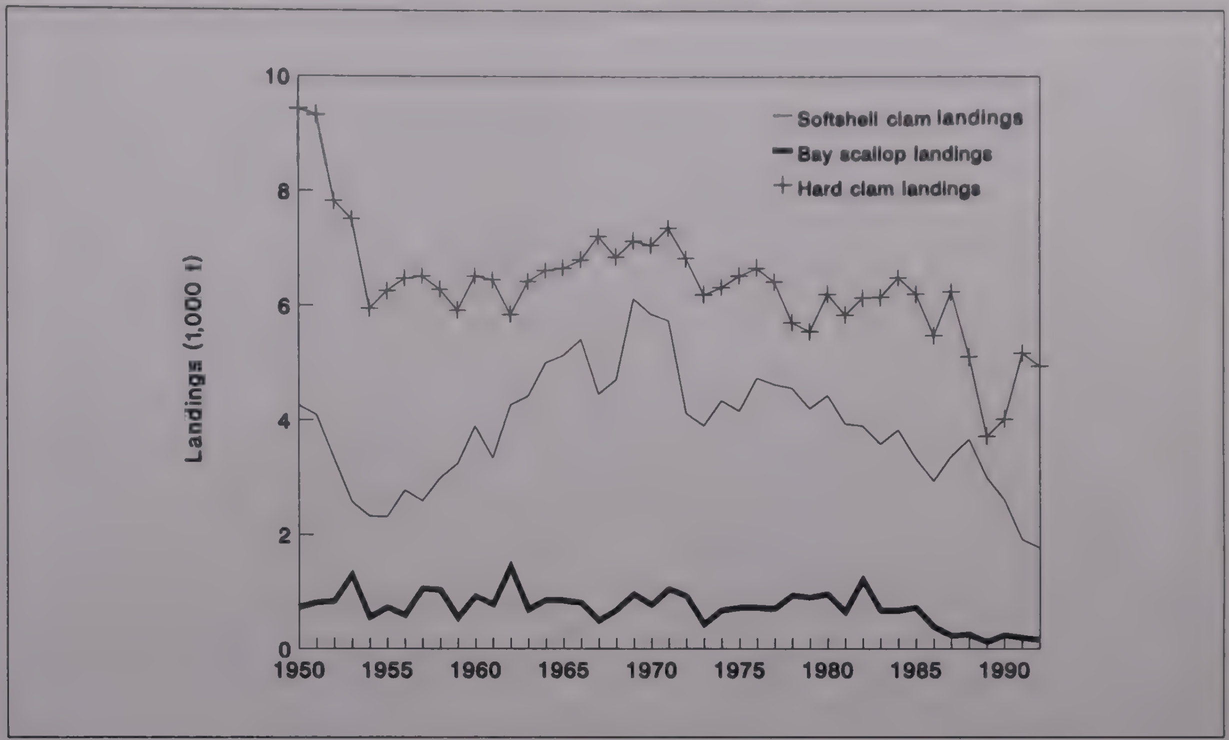


Figure 21-1.—Commercial landings of hard and softshell clams and bay scallops from the U.S. Atlantic and Gulf coasts, 1950-92.

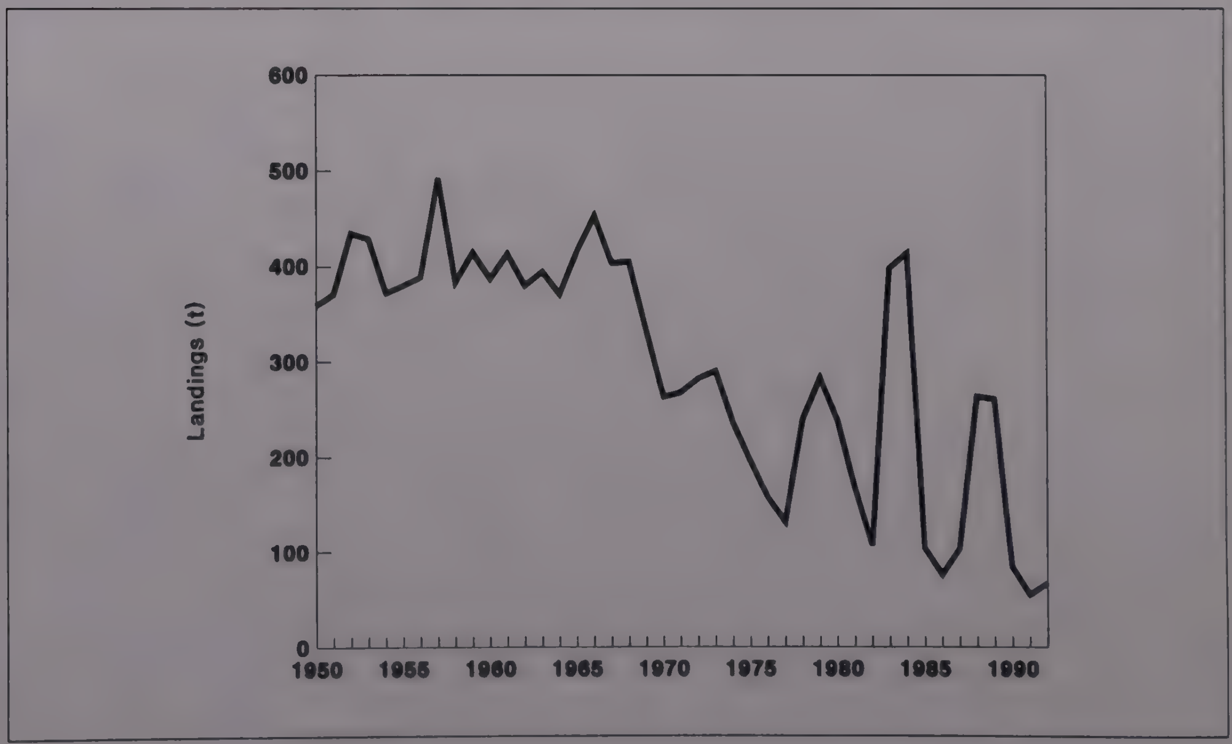


Figure 21-2.—Commercial abalone landings from the U.S. Pacific coast, 1950-92.

. . . SPECIES AND STATUS

them as gamefishes.

It is difficult to assess the status of these stocks throughout their ranges because they are under varied management and data collection systems; though individual states may collect data and assess stocks of several of these species, comprehensive assessments are scarce. Many of the species in Table 21-1 are probably overexploited, at least in part of their ranges, as with the Chesapeake Bay oyster. Others, like many of the herrings, are difficult to assess because the data on abundance and stock structure are sparse, dispersed, or nonexistent. Stock levels of many of these species are below their historical averages. Whereas relatively good biological data exist for species such as oysters and blue crabs, they are incomplete for many other species in this unit.

The recent annual yield of the species in this unit is conservatively estimated at more than 221,000 t. Table 21-1 presents the best data available, though the yields are probably low for many species because separate landings data are not al ys

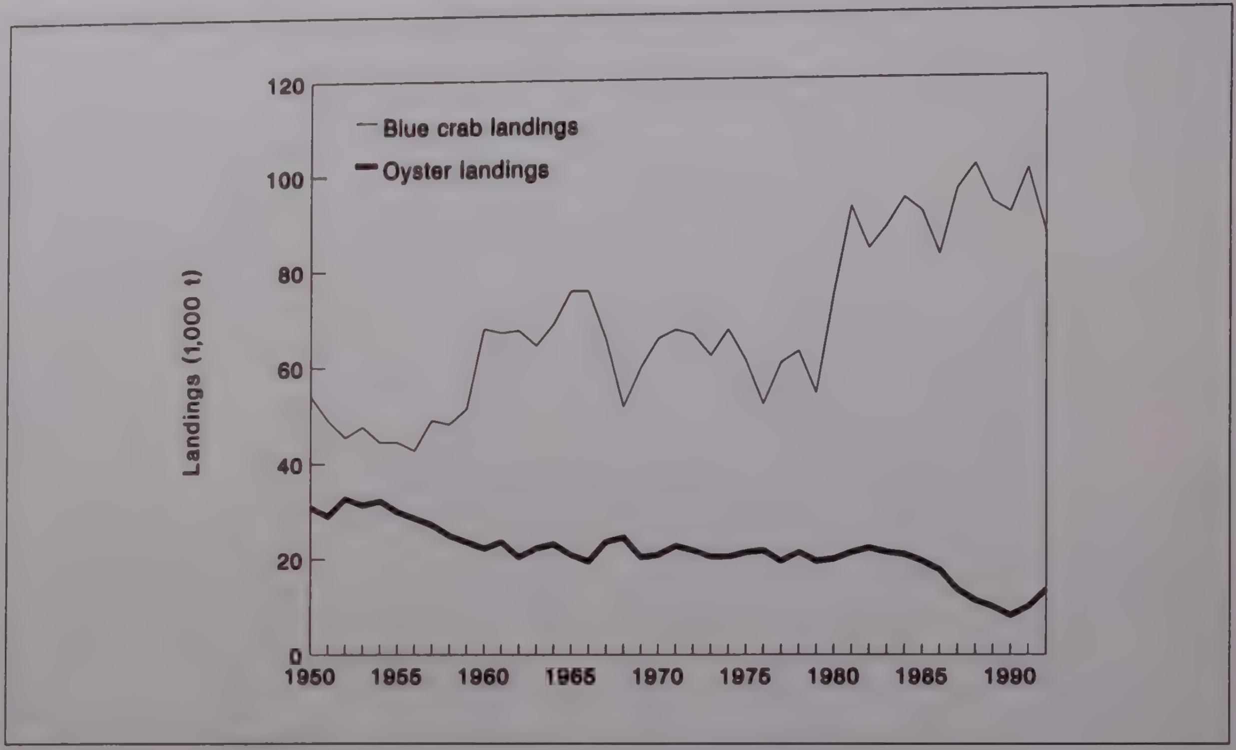


Figure 21-3.—Commercial blue crab and oyster landings from the U.S. Atlantic and Gulf coasts, 1950-92.

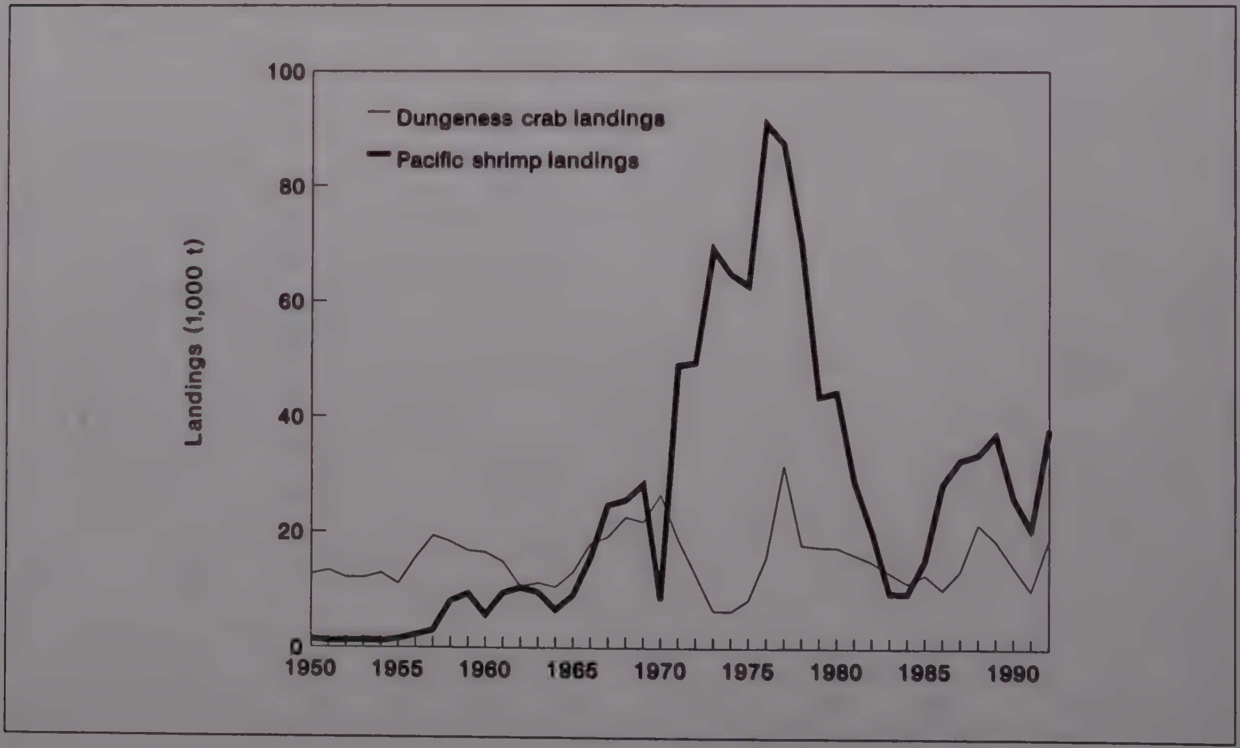


Figure 21-4.—Commercial Dungeness crab and Pacific shrimp landings from Oregon, California, and Washington, 1950-92.

. . . SPECIES AND STATUS

reported (many of the baitfishes are lumped into other categories, for example). Furthermore, data on sport catches are not available for many of these species, particularly the invertebrates. Recreational aspects of some of these fisheries are very large; Chesapeake Bay sport crabbers alone caught an estimated 19,000 t of blue crabs in 1983 and 9,800 t in 1988, or 44% and 32.1% of the total harvests, respectively. Some species, such as tarpon and bonefish, are sought primarily for sport and are usually released alive; consequently, few or no landings data for them are reported even though they provide significant local and regional economic benefits.

ISSUES

Habitat Concerns

Because of their reliance on nearshore habitats (i.e. estuaries, reefs, mangroves, etc.) species in this group are particularly susceptible to habitat loss, pollution, changes in freshwater flows, siltation, and other environmental problems. Striped bass have been hurt by habitat degradation and salinity changes in the San Francisco Bay estuary; Chesapeake Bay species, such as river herrings and hickory shad, have declined drastically in recent years due to pollution, waterflow changes and habitat degradation; and Atlantic coast and Gulf of Mexico oyster and hard clam harvests have been severely reduced by pollution, disease, salinity changes, and habitat losses. More than half of the Nation's original acreage of coastal wetland marshes have disappeared, and dramatic declines in seagrass beds have occurred. Louisiana alone loses an estimated 35,200 acres of coastal wetlands habitat each year.

Because many shellfish fisheries are close to large population areas, the likelihood of pollution problems is high; fishing closures due to shellfish bed contamination cause large economic losses each year. In addition to direct pollution impacts, excessive nutrient loads may increase toxic plankton blooms that cause red tides and paralytic shellfish poisoning. Mosquito control spraying near populated areas, such as in southern Florida, may result in death of juvenile fishes in important nursery areas. Environmental stresses also make fish more susceptible to diseases and parasites, either killing them outright or making them difficult or impossible to market. The diseases MSX and "dermo" have destroyed millions of bushels of oysters in Delaware and Chesapeake Bays since 1958, and they spread in the late 1980's to coastal North Carolina where similar devastation has occurred.

Management Concerns

Overharvesting has been at least partially responsible for depleting such species as Pacific razor clams, Pismo clams, abalones, oysters, and snook. Marine mammals also feed on some of these species and may compete with fishermen; for example, sea otters on the Pacific coast have depleted abalone and sea urchin stocks in parts of California.

ATLANTIC MARINE MAMMALS

INTRODUCTION

Marine mammals have been historically important in the United States both as targets for commercial harvests and in ecological interactions with commercial fisheries. Some scientific attention was given to marine mammals as early as 1851 when Matthew F. Maury of the U.S. Navy's Depot of Charts and Instruments published his whale charts based upon whalers' logs and records of sightings. The U.S. Fish Commission, after its creation in 1871, gave more attention to marine mammals, commissioning, for example, Starbuck's 1878 "History of the American Whale Fishery." The omnibus series titled "The Fisheries and Fishery Industries of the United States" by G. B. Goode and Associates in 1884 described fisheries for the great whales as well as smaller whales (e.g. pilot whales, bottlenose dolphins, and bottlenose whales) in the North Atlantic.

In addition to these direct fisheries, there was also interest in the indirect effects of marine mammals on other fisheries. Goode also described the destructiveness of marine mammals to fisheries, a theme that the U.S. Commissioner of Fisheries used in 1889 in supporting a fish meal factory to be built in Woods Hole. The commissioner speculated that the 20 tons of predators such as porpoises, skates, and dogfish that the proposed factory would process annually "should present a marked influence upon the sup-ply of edible fishes." The interest of the U.S. Fish Commission was primarily in terms of fisheries, and little biological study appears to have been done of marine mammals in this region beyond the taxonomic studies of Frederick True starting in the 1880's. For example, he provided written instructions to the lighthouse keepers on "the best means of collecting and preserving specimens of whales and porpoises."

With the declining importance of the U.S. harvests of east coast species of marine mammals in the late 1800's and early 1900's, the incentive for systematic scientific study of the species inhabiting northeastern U.S. waters declined. In the 1930's and 1940's, Remington Kellogg at the Smithsonian and William Schevill at Harvard undertook taxonomic studies, but it wasn't until the late 1940's that cetacean biology began to be investigated more systematically. Then Schevill began a series of investigations at the Woods Hole Oceanographic Institution of cetacean acoustics that are still continuing. In the early 1970's, several other researchers began studying marine mammals in this region. The results of this earlier work was addressed in 1979 when the U.S. Marine Mammal Commission sponsored a workshop to help define research needed for the study of marine mammals on the U.S. east and Gulf coasts and in 1989 at a NMFS-sponsored workshop on Gulf of Mexico marine mammal research needs.

These workshops set a research agenda that was immediately addressed by agencies such as the Minerals Management Service (MMS) and the National Marine Fisheries Service. During the 1980's, several institutions in the northeast developed active research programs which have resulted in a body of knowledge that is being drawn upon in developing management approaches for several critical marine mammal issues in the region. In the 1990's, increased attention has been focused on the characterization of marine mammal fauna of the U.S. Gulf of Mexico and the Mid-Atlantic Bight.

SPECIES AND STATUS

Thirty-five species of marine mammals range the U.S. Atlantic and Gulf of Mexico waters (32 whales, dolphins, and porpoises, two seal species, and one manatee). Their status is poorly known, but some, like the northern right whale, Atlantic coastal bottlenose dolphin, and harbor porpoise, are under stresses that may affect their survival. Others, like the harbor seal, are increasing in abundance.

Table 22-1 summarizes what is known about the status and trends of several Atlantic marine mammals. Brief summaries for selected species give additional data on distribution, current and historical abundance, and population trends.

Table 22-1.—Stock assessments of selected marine mammals in U.S. waters of the North Atlantic Ocean.

Species and area	Abundance	Status	Trends	Status in U.S. waters
Fin whale (Northeast U.S.)	5,200	Endangered	Unknown	Endangered[1]
Humpback whale (N.W. Atlantic)	5,100 (2,888-8,112)[2]	Possibly 65% of its population size in about 1850.	Unknown	Endangered
Northern right whale (N.W. Atlantic)	350	Probably <5% of its original size.	Unknown	Endangered
Pilot whales (Northeast U.S.)	Unknown	Unknown	Unknown	
Bottlenose dolphin (Northeast U.S.)	Unknown (10,000-13,000)[3]	Coastal type Offshore type	Unknown Unknown	Depleted[4]
(U.S. Gulf of Mexico)	(35,000-45,000)[3]	Offshore and coastal types	Unknown	
Whitesided dolphin (Northeast U.S.)	27,600 (17,254-37,946)[2]	Unknown	Unknown	
Spotted dolphin (Northeast U.S.)	200	Unknown	Unknown	
Harbor porpoise (Gulf of Maine)	47,200 (26,700-86,400)[2]	Unknown	Unknown	Proposed as threatened[5]
Harbor seal (Northeast U.S.)	26,000[2]	Unknown	Increasing	
Beaked whales (Six species in northeast U.S. waters)	Unknown	Unknown	Unknown	

[1]Listed as endangered under the Endangered Species Act (ESA).
[2]95% confidence interval.
[3]Rough estimate.
[4]Listed as depleted under the Marine Mammal Protection Act.
[5]Proposed as threatened under the ESA.

Bottlenose Dolphin

The number of discrete bottlenose dolphin stocks is unknown. There appear to be offshore and coastal types, possibly forming at least two distinct populations. There are no comprehensive population estimates, but abundance in the Gulf of Mexico is estimated at 35,000-45,000 in waters of 100 fm or less. Aerial surveys between Cape Hatteras and Nova Scotia in 1979-82 suggest a northeast U.S. total of 10,000-13,000 individuals. However, a large die-off of bottlenose dolphins in 1987-88 may have resulted in a 50% or greater decline in the nearshore or coastal type. As a result of that mortality, the population has been classified as depleted under the MMPA. A survey of the nearshore environment from New Jersey to Cape Hatteras in 1987 resulted in an estimate of abundance of 1,050-7,500 dolphins, which were assumed to be of the coastal type.

Pilot Whale

Two species of pilot whales occur in the North Atlantic, the shortfin pilot whale in the south and the longfin in the north. The range of the two species overlaps seasonally in the Mid-Atlantic region of the western North Atlantic. The longfin pilot whale occurs northward into Canadian and Greenland waters and eastward to Europe; it is subject to an ongoing harvest around the Faroe Islands and incidental capture in several fisheries in U.S. and Canadian waters. The shortfin pilot whale may be subject to a low level of bycatch in several U.S. fisheries. Population structure and general life history of both species is very poorly known. Abundance has been estimated for the longfin pilot whale in the eastern North Atlantic (750,000) and for the continental shelf region of the western North Atlantic (roughly 11,000).

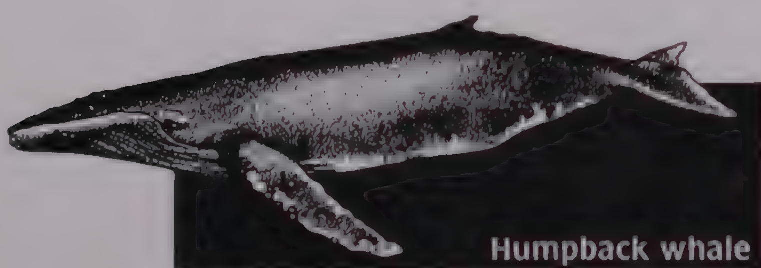
Fin Whale

Fin whales, listed as endangered under the ESA, are probably the most numerous large cetaceans in temperate waters of the western North Atlantic Ocean. They range widely throughout the continental shelf in all seasons, but most sightings occur from the Great South Channel on Cape Cod, north throughout the southwest Gulf of Maine. Stock structure and total abundance are unknown. An estimate of abundance off the northeast coast in 1979-82 was 5,200 in spring and 1,500 in winter.

Important research and management questions are whether separate stocks exist, the location of calving grounds and annual calf production, and the location of the wintering grounds for the northwest Atlantic population.

Humpback Whale

The humpback whale is listed as endangered. Reasonably discrete summer stocks occur in the Gulf of Maine, Gulf of St. Lawrence, and the waters of Newfoundland-Labrador, west Greenland, Iceland, and Norway. The estimated total population is about 5,100 whales. Along the northeast coast, humpbacks frequent the Great South Channel, Georges Bank, Stellwagen Bank, and Jeffreys Ledge during summer. A minimum estimate of the population prior to commercial whaling (about 1865) was 4,400-4,700 humpbacks.


Humpback whale
Megaptera novaeangliae

Entanglement with fishing gear and sporadic toxin-induced die-offs are problems for the species. In recent years the number of sightings of young humpbacks in the Mid-Atlantic region has increased, generally in the areas of the Chesapeake and Delaware bays.

Right Whale

Northern right whales occur on the continental shelf from Florida to Nova Scotia. The endangered western North Atlantic stock is the only northern hemisphere right whale population with a significant number of individuals (300-350)—the other stocks being virtually extinct. The pre-eighteenth century population may have been as high as 10,000, and, if so, the current population is more than 95% depleted.

Individual identification, satellite tagging, genetic analysis, and the use of video cameras to document behavior are new research methods that have been applied in recent years. Many questions, however, remain. Among them are the location of summering grounds for 30% of the population and wintering grounds for 80% of the population. Human impacts (net entanglement and ship strikes) are affecting some 60% of the population and may be inhibiting recovery. Two areas important to the northern right whale, the summer feeding grounds off the New England coast and the winter calving area along the Georgia and northern Florida coast, have recently been proposed as critical habitat.

Harbor Porpoise

The northwestern Atlantic harbor porpoise is found from Newfoundland, Canada, to Florida. It is hypothesized that there are three populations: Newfoundland, Gulf of St. Lawrence, and Gulf of Maine-Bay of Fundy. However, there is not enough evidence to test this hypothesis against the alternative of a single population. Summer aggregations occur in the Gulf of Maine, Gulf of St. Lawrence, and the east coast of Newfoundland. The winter distribution is poorly understood. The 1991-92 population estimate of the Gulf of Maine population is 47,200 (95% CI: 32,800-68,000). No useful estimates of abundance for the other populations exist. The average estimate of annual mortality by the U.S. Gulf of Maine sink gillnet fishery from 1990 and 1992 is about 1,700 (range 900-2,400). These estimates do not include bycatch from fisheries south of Cape Cod or north of the U.S. border. The estimated bycatch of the other two populations is largely unknown, though some new data do exist for the Bay of Fundy, which are currently being analyzed.

Harbor Seal

Harbor seals, year-round residents of Maine and eastern Canada, are seasonal-winter residents in southern New England (SNE). Harbor seal numbers have apparently increased in recent years, due primarily to protection under the MMPA. Recent surveys suggest that 26,000 harbor seals occur in the Gulf of Maine, and they are increasing. Bycatch levels are relatively low, and major concerns are competition with fisheries and periodic disease outbreaks.

Beaked Whales

There are four species of beaked whales in the northwest Atlantic, however little is known on their distribution, biology, and population structure. Based on cetacean surveys conducted during the early 1980's and 1990's, these species are distributed along the shelf edge (2,000 m), principally along the southern edge of Georges Bank and associated with oceanographic fronts and Gulf Stream meanders. Population estimates for these species are not available. Determination of minimum abundance estimates will require substantial survey effort in shelf-edge waters and waters seaward to at least the Gulf Stream off the northeast U.S. and eastern Canada coasts.

ISSUES

Bycatch and Multispecies Interactions

Studies of marine mammal populations have focused on three primary questions: 1) Have fisheries interactions and other human-related activities directly harmed marine mammals or adversely altered their environment; 2) Are the depleted and endangered marine mammals recovering, and have the best steps been taken to speed their recovery; and 3) What actions are necessary to minimize potential conflicts between the ESA, MMPA, MFCMA, and other Federal laws on marine resources and fisheries management?

Much attention has been focused on the first of the three questions, in monitoring the numbers of marine mammals killed due to human-related causes and in attempting to determine the size of marine mammal populations. Current methods for estimating abundances, and thus, trends of marine mammal populations, require a significant effort and expense and take many years to obtain desired levels of precision. These surveys are continuing and will need to be repeated at regular intervals to provide the best advice for management of marine mammal populations.

In the meantime, there are some populations thought to be at risk or otherwise of significant management concern. For example, the bycatch of harbor porpoise in sink gillnet fisheries in U.S. and Canadian waters appears to be large relative to likely levels of natural production for this species. The magnitude of this bycatch and the abundance of this species were reviewed in an international scientific workshop in May 1992, and it was recommended that the bycatch should be reduced. Three methods for accomplishing this have been identified: Setting maximum catch limits annually, setting time and area closures, and modification of the sink gillnet fishing gear. Evaluation of these options and research necessary to actually implement one or more of them are of high priority.

Bycatch of other species in this region is lower than that for harbor porpoise, but its significance is not known because of uncertainties about abundance of those species. Of special concern is the bycatch of several species of beaked whales in the U.S. drift gillnet fishery for swordfish.

Human activity may have a profound influence on the recovery of northern right whales in the Atlantic. The population was depleted by over exploitation to such an extent that net gains in population size have been extremely slow. The annual loss of even a single right whale incidental to human activity, such as being struck by a merchant ship or entangled in fishing gear, may prohibit or significantly prolong their recovery to the point where northern right whales are no longer fully functional members of their marine ecosystems.

Increasing populations of pinnipeds, particularly harbor seals and grey seals, present a different management issue. Commercial activity, such as fishing and coastal development, has become a major source of income for many people in [illegible]

... Bycatch and Multispecies Interactions

ing U.S. coastal areas. This growth of commercial activity occurred during a period when marine mammals were severely depleted due to over exploitation by humans, whether for direct commercial purposes or to reduce human-perceived competition for resources. Now that some species are beginning to recover toward pre-exploitation levels, conflicts between the increasing populations of marine mammals and human activity are beginning to surface. For example, harbor and grey seals may prey upon Atlantic salmon being raised in commercial net pen operations. The resolution of these conflicts presents a management problem that did not exist while marine mammal populations were severely depleted.

Recovery of Protected Species

Over the past year Endangered Species Recovery Plans have been completed for the humpback and right whales in this region. These plans outline comprehensive management and research agendas that would take initial steps toward ensuring the recovery of these species. Critical issues for both species are entanglement and mortality in fishing gear. For the humpback whale, entanglement occurs especially in Canadian waters, making it important to determine the genetic relationship between animals in U.S. and Canadian waters to assess the effects of this bycatch.

In addition to entanglement, the right whale appears to be prone to collisions with ships, which may kill or seriously injure individuals. The mitigation of these human impacts on right whales is listed as a Priority One Item in the Implementation Schedule of the national Right Whale Recovery Plan. This topic was also seen as a top priority by participants in the Right Whale Workshop convened by NOAA/NMFS in Silver Spring, Maryland, in April 1992.

Over the past few years, there have been several instances of unusual mortality events which have affected marine mammal populations. Such events have been detected in harbor seals, humpback whales, and bottlenose dolphins along the Atlantic and Gulf of Mexico coasts. About 350 dead harbor seals were recovered along the New England coast during an influenza outbreak in 1979-80. A smaller outbreak of the same disease occurred in 1982. Although there were not high levels of mortality, stranding network members were responsible for isolating phocine distemper in harbor seals in 1992. The same disease was responsible for the death of over 17,000 seals in Europe in 1988. In late 1987, 14 humpback whales apparently died due to the presence in prey species of a biotoxin associated with algal blooms.

Three different mortality events affected bottlenose dolphins in the last few years. A major mortality event affected the coastal migratory stock on the east coast in 1987-88. It was estimated that the population declined over 50% and, as a result, this stock has been designated as depleted. In the winter and spring of 1990, mortality levels of bottlenose dolphins along a portion of the Gulf coast were much higher than usual. In 1992, over 100 dead bottlenose dolphins were recovered from a two-county area of Texas within a two-month period. Large numbers of fish were also killed. Survey results suggest that it is unlikely that these mortalities had a significant impact on the population.

The stranding network is an important source of information on the biology of marine mammals. Data on vital rates, condition of the populations, and importantly, sources of mortality, can be acquired from stranded animals. For example, stranded animals with remnants of fishing gear indicate fishery interactions in areas or fisheries not participating in observer programs. Furthermore, examinations of stranded animals can indicate other causes of death from human interactions; for example, ship collisions are known to be a significant source of right whale mortality because of such evidence. Increased efforts to examine fully every stranded marine mammal are necessary to give a broader-based information base on causes of mortality and basic biology.

Progress

The NMFS research program on marine mammals in the U.S. Atlantic Ocean and Gulf of Mexico has resulted in significant improvements in our knowledge of these species. Most recent research has focused on three areas: Estimates of distribution and abundance, estimates of total bycatch, and estimates of vital rates.

Surveys conducted since 1990 have established the relationship of the distribution of several species of toothed whales to the Gulf Stream wall and warm core rings, and have confirmed the strong relationship to the continental shelf break. Revised estimates of abundance for these species are being developed. Surveys of harbor porpoise conducted since 1987 have mapped their summer distribution pattern, and have allowed development and testing of sighting survey methods for estimates of absolute abundance.

A coordinated international multi-investigator study, Years of the North Atlantic Humpback Whale (YONAH), is underway for 1992-95. At the conclusion of the project, the geographic distribution, abundance, behavior, and genetic structure of North Atlantic humpback whales will be known more precisely and reliably than has ever been possible for any pelagic whale species in an entire ocean basin. The project will be a model for the foundation of studies required for comprehensive understanding, conservation, and management of a cetacean species.

A multi-agency, multi-investigator effort to study right whales on their wintering and calving grounds off the southeastern United States and to develop a program to mitigate the impact of human interference with right whales has been underway since 1988. The results are expected to provide a model for efforts aimed at assisting the recovery of this endangered species.

A program of placing observers aboard commercial fishing vessels has resulted in new estimates of bycatch rates of harbor porpoise and other species. By combining these with estimates of total fishing effort in several fisheries based on a previously existing port sampling program, estimates of total bycatch have been made. These have been completed for harbor porpoise for three years and are being developed for other species. These data collection programs are also enabling development of an understanding of seasonal bycatch patterns which may provide a basis for seasonal and area controls on fisheries to reduce the bycatch.

Biological sampling of the marine mammals killed in commercial fishing operations has been conducted with a very high degree of cooperation from fishermen. These samples are being analyzed in conjunction with samples from other regions to determine population structure and net reproductive rates. For example, recent results suggest that harbor porpoise from across the North Atlantic are more closely related than those in other regions, and that the natural mortality rates of pilot whales are high for younger and older animals but very low for middle-aged animals.

In an effort to establish baseline data on contaminants in marine mammals, NMFS has established a National Marine Mammal Tissue Bank. Ultimately, the Bank will contain tissues of the highest quality maintained in a manner that allows their accurate use for retrospective analysis. A pilot project has been completed using tissues from stranded pilot whales and from harbor porpoises caught incidentally in fisheries. The Tissue Bank project also has recognized the need to establish consistency in tissue analysis and has set up a quality assurance program available to any laboratory analyzing contaminant levels in marine mammals. As part of this effort, standard reference materials with known contaminant levels are being developed for use in calibration.

PACIFIC MARINE MAMMALS

INTRODUCTION

In 1791, New England whalers first rounded Cape Horn, and by 1820 they had pressed on to Hawaii where they began to take on provisions and recruit men for their northern summers in bowhead-whale-rich Alaskan waters. An average bowhead yielded 100 barrels of oil, making the fishery attractive to whalers, even though over 100 whaling ships were lost between 1826 and 1900 due to crude charts and icy Alaskan waters.

California's whaling industry is documented back to the mid 1850's when shore whaling stations were set up, ranging from the state's northernmost border at Crescent City south to San Diego. With a hunting range of about 10 miles, shore fisheries harvested only whales frequenting the nearshore waters. The northern stations targeted humpback whales at first, but included gray whales in short order; southern stations took advantage of the natural southward migration patterns of the gray whale.

Sea lions, reported to be abundant along the California coast and offshore islands before 1860, were also exploited for food, oil, and clothing. From 1860 to 1870, thousands were harvested for oil. In 1915 and 1916, a bounty of $2.00 each was paid on 4,074 sea lions. From the late 1920's until passage of the MMPA in 1972, commercial and sport fishermen were allowed to kill sea lions that interfered with their fishing operations.

The Hawaiian monk seal is thought to have been abundant when Europeans discovered the Hawaiian Islands. However, overexploitation made this seal the endangered species it is today.

Before passage of the Marine Mammal Protection Act and the Endangered Species Act the only protective measures for marine mammals were through the International Whaling Commission (IWC), and those were for only certain depleted large whales.

All marine mammals are now protected by the MMPA and by the ESA. Other management responsibilities are addressed in the Magnuson Fisheries Conservation and Management Act, which extends the jurisdiction of the MMPA throughout the U.S. exclusive economic zone, and the Whale Conservation Act, which was intended to further aid the recovery of whales.

SPECIES AND STATUS

At least 50 species of marine mammals occur in U.S. Pacific waters (36 whales, dolphins, and porpoises; 11 seals and sea lions; walrus; polar bear; and sea otter). Fourteen are commonly seen along the coast (gray whale, bottlenose dolphin, harbor seal, and others), whereas the 28 others frequent offshore or remote island waters (beaked whales, ribbon seal, Hawaiian monk seal, and others), or are severely reduced in numbers and thus seldom seen (North Pacific right whale and Guadalupe fur seal, for example).

Table 23-1 summarizes what is known about the status and trends of several Pacific marine mammals. Brief discussions below for selected species give additional data on distribution, current and historical abundance, and population trends.

Eastern Tropical Pacific (ETP) Dolphins

Four species—spotted, spinner, striped, and common dolphin (12 stocks)—are incidentally taken in the international fishery for yellowfin tuna in the tropical Pacific waters off Mexico and Central America. Until the 1980's, the U.S. maintained the largest fleet in the fishery. Although mortality of dolphins was in the tens and hundreds of thousands for the first decade of the fishery, that mortality has been reduced in recent years (less than 20,000 were killed in 1992). Because these four species also occur in U.S. waters, and because the U.S. was the major market for the fishery, NMFS initiated assessments of these populations.

Three stocks of spotted dolphin are currently recognized in the ETP: the northeastern stock, the west/south stock, and the coastal stock. Based on analyses of five years of research vessel data, the population size for the northeastern stock is estimated to be 731,000 individuals, for the west/south stock, 1,298,000 individuals, and for the coastal stock, 36,000 individuals. Eastern spinner dolphins

Table 23-1.—Stock assessments of selected marine mammals in U.S. North Pacific Ocean waters.

Species and area	Abundance	Status	Trends	Status in U.S. waters
Fin whale	935	Unknown	Unknown	E[2]
Northern right whale	16	Unknown	Unknown	E
Bowhead whale (W. Arctic)	7,500 (6,400-9,200)[1]	Current population size is 40.9% (38.0-42.0%) of the 1848 population size.	Increasing at 3.1% (0.1-6.2%)/year, 1978-88	E
Gray whale (N.E. Pacific)	20,869 (19,200-22,700)[1]	Recovered to approximately the abundance levels of 1845.	Increasing at 3.3%/year (2.3-4.2%) (CV=0.04)[1], 1968-88	E[3]
Humpback whale (E. Pacific)	1,407	Probably less than 15% of abundance prior to 1850.	Unknown	E
Harbor porpoise		Unknown	Unknown	
(Southeast Alaska)	2,502 (CV=0.26)			
(W. Gulf Alaska)	1,273 (CV=0.17)			
(N. California)	10,000			
(Cent. California)	3,806			
(Inland Washington)	3,298 (CV=0.26)			
(Oregon/Washington)	23,701 (CV=0.18-0.26)			
Hawaiian monk seal	1,550	Endangered. Declined by 50% since 1950's.	Unknown. Pup counts declining to variable, no trend.	E
Northern fur seal (Pribilof Islands)	982,000	Current level is <40% of the population of the mid-1950's.	No significant trend since 1983 on St. Paul.	D[4]
(San Miguel)	6,000		Increasing	
Steller sea lion (N. Pacific)	116,000[5]	Currently <22% of size of the late 1950's.	Declined 80% since 1960.	T[6]
California sea lion (California-Washington)	111,016	Unknown, but believed to be at within DSP levels.	Increasing at 10.2%/year since 1983.	
Harbor seal		Unknown		
(Alaska)	63,000		Increasing?	
(California)	count=23,113		Declining	
(Oregon-Washington)	45,713		Increasing	
			Increasing	
ETP Dolphins				
Northeastern spotted	731,000 (588,700-970,400)[1]	Depleted	Declining (1985-90) based on analysis of tuna vessel observer data (TVOD)	
West/South spotted	1,298,000 (1,654,100-918,700)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
Coastal spotted	30,000 (15,100-50,800)[1]	Unknown	Stable(1985-90) based on analysis of tuna vessel observer data (TVOD)	
E. spinner	631,800 (389,500-938,300)[1]	Depleted; currently 44% of size in late 1950's	Stable (1985-90) based on analysis of TVOD	D
Whitebelly spinner	1,019,000 (694,400-1,456,200)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
N. common	476,300 (200,600-807,300)[1]	Unknown	Declining(1985-93) based on analysis of TVOD	
Cent. common	406,100 (200,300-766,000)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
S. common	2,210,900 (1,536,600-3,488,200)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
Common (pooled)	3,093,300 (1,937,500-5,061,500)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
Striped	1,918,000 (1,531,800-2,249,300)[1]	Unknown	Stable (1986-90) based on analysis of research vessel observer data	

[1]95% confidence interval. CV=coefficient of variation.
[2]E = Listed under the Endangered Species Act as endangered.
[3]The California stock of gray whales is proposed to be removed from the list of endangered species.
[4]D = Listed under the Marine Mammal Protection Act as depleted.
[5]Range-wide estimate.
[6]T = Listed under the Endangered Species Act as threatened.

... Eastern Tropical Pacific (ETP) Dolphins

number 632,000, whereas the whitebelly spinner dolphins number about 1,019,000. Stock specific estimates of common dolphin abundance were based on too few sightings and are considered unreliable; therefore in 1992, NMFS initiated research vessel surveys designed specifically to obtain estimates of abundance for common dolphin stocks. A pooled estimate of 3,093,300 encom- passes the northern, central, and southern stocks of common dolphin. Striped dolphin are currently considered to consist of a single stock in the ETP with an estimated abundance of 1,918,000 individuals.

Relative abundance estimates have also been generated from dolphin sightings obtained using tuna vessel observer data (TVOD). Trends in these estimates suggest that most dolphin stocks declined in the 1970's, but have been relatively stable since the 1980's. The northern stock of common dolphin is an exception. A significant decrease in sightings has been observed in the ETP. The cause(s) of the decrease in this region is not clear, but it has been suggested that if the decline cannot be attributed to fishery mortality, then it may have been caused by a shift in distribution in response to environmental fluctuations.

Harbor Porpoise

Harbor porpoise appear to have more restricted movements along the western U.S. coast than along the eastern coast. Studies have shown some indication that harbor porpoise do not mix freely between California, Oregon, and Washington. Regional differences have also been seen within California; therefore, it has been recommended that animals inhabiting central California be treated as a separate stock for management purposes.

The current estimate for the central California stock is 3,806. The combined estimate for northern California, Oregon, and Washington outer coast is 45,713, and for the waters of Puget Sound is 3,352. The species was once abundant in Washington's inland waters, especially southern Puget Sound, but its abundance is very low there now. Harbor porpoise tend to concentrate at the mouth of the Columbia River and at many other bays. The kill of harbor porpoise is largely limited to set gillnet fisheries for halibut and rockfish in central California (coastal setnets are not allowed in northern California, and harbor porpoise do not inhabit southern California). In recent years, the kill has decreased primarily as a result of decreased fishing effort in areas of high harbor porpoise concentrations.

Bowhead Whale

The endangered bowhead whale has ranged as far as the polar ice fields of the Northern Hemisphere. Total pre-whaling abundance is believed to be 12,000-18,000, but by 1900 it was probably in the low thousands. In the U.S. western Arctic, 18,650 bowheads were killed by Yankee whalers between 1848 and 1914 from a population estimated at less than 20,000. The take by Alaska Eskimos has averaged 20-40 whales per year since 1914. The present population, 7,500, is about 41% of its 1848 carrying capacity. The stock has been increasing since commercial whaling ended and has grown by 3.1%/year since 1978 (Fig. 23-1).

Gray Whale

Still listed under ESA as endangered is the western stock of North Pacific gray whales. The eastern North Pacific or "California" stock was heavily exploited by Yankee whalers in the last half of the 19th century. The 1987/88 stock size, 20,869, is believed to be equal to or larger than the estimated size of the 1846 population of 15,000-20,000, but below estimates for a carrying capacity of 24,000. Population growth rate was 3.3%/year between 1967 and 1988, despite a subsistence catch of 167 whales per year by the former Soviet Union (Fig. 23-2). In light of this recovery, the Secretary of Commerce has determined that the eastern Pacific stock should be removed from the ESA's list of endangered and threatened wildlife.

Figure 23-1.—Actual count of bowhead whales, 1978-88.

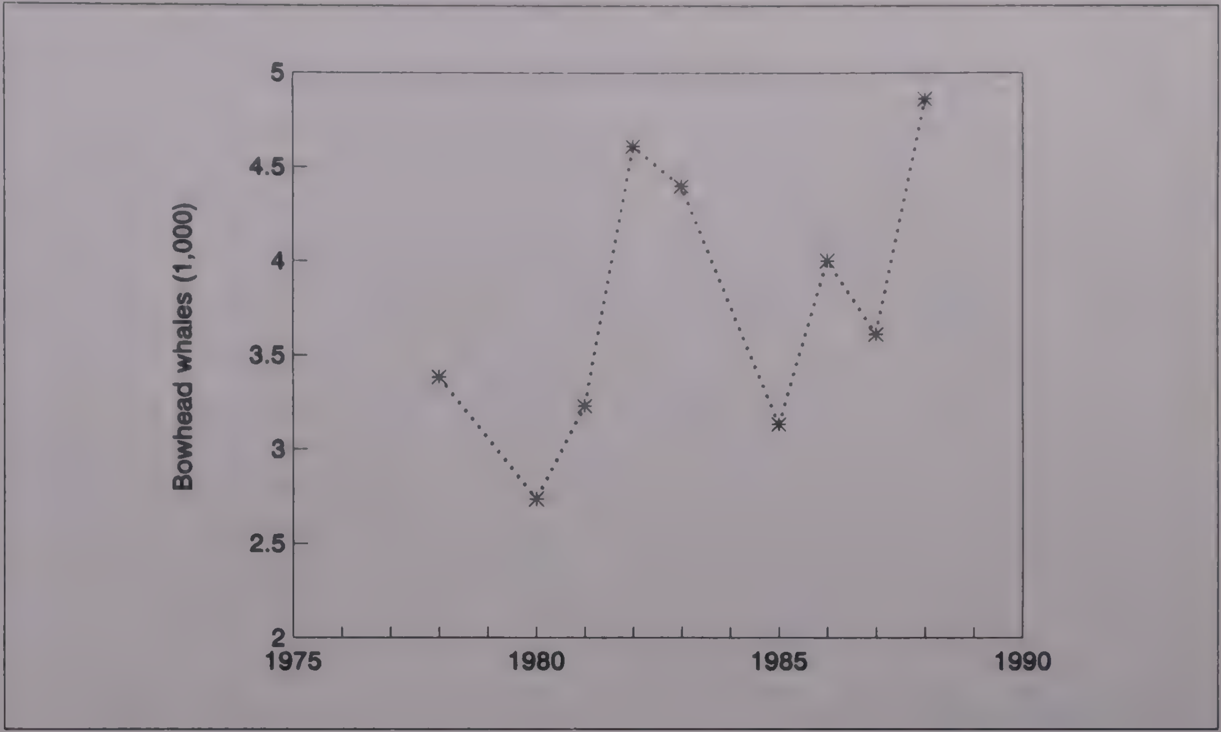
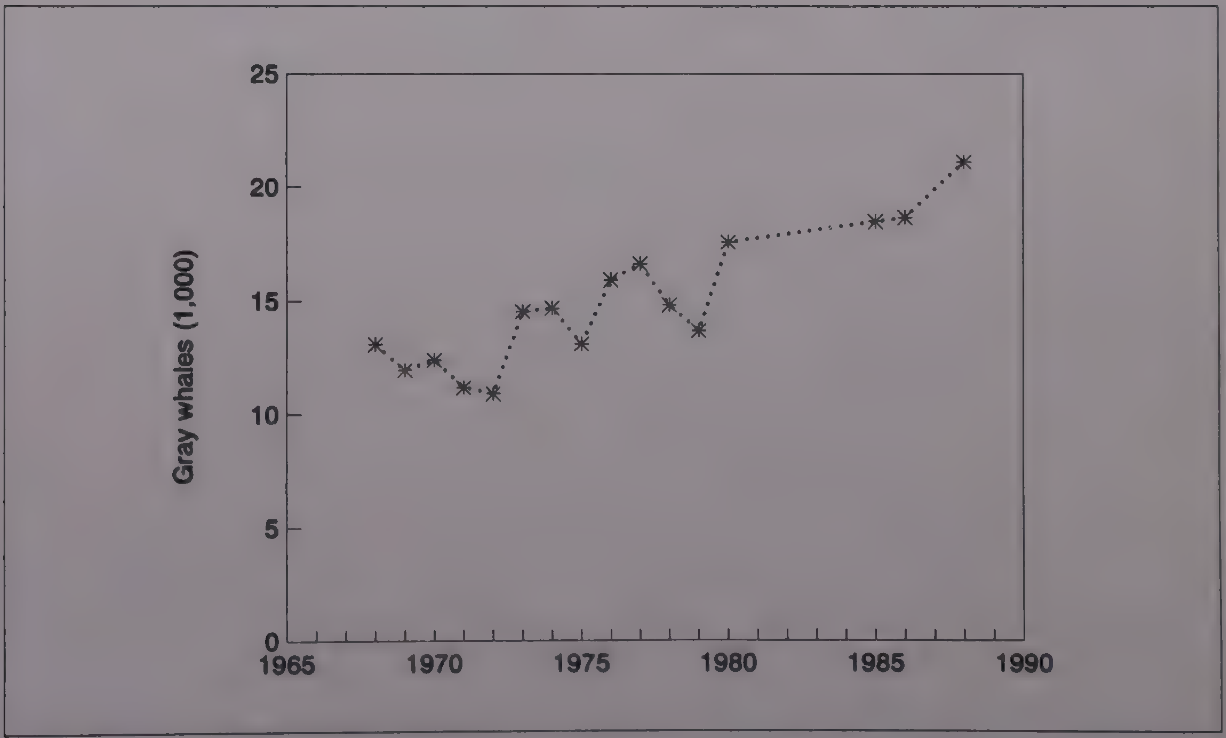


Figure 23-2.—Estimated population of gray whales, 1965-90.



Humpback Whale

The endangered humpbacks in the eastern North Pacific Ocean migrate between the subtropical waters of Hawaii and coastal Mexico during the calving season and the temperate and subarctic waters of northern California and Alaska where they feed. Previously, humpback whales were estimated to be at 13% of their pre-whaling population size estimate of 15,000 (ca. 1850). More recent preliminary analysis of photographic identification of individual whales in the North Pacific suggests that the total population may exceed the current estimate of 1,398-2,040 individuals. Detailed analyses of the available data may provide a better understanding of the status of these whales.

Northern (Steller) Sea Lion

The northern or Steller sea lion, classified as threatened under the ESA, ranges in coastal waters of the North Pacific Ocean from California to Japan. The species has declined sharply throughout its range in just the last 20 years, and it is now well below its optimum level. The number of adults and juveniles in U.S. waters crashed from 154,000 in 1960 to 40,000 in 1992. Most of this 73% decline occurred in Alaska waters between Kenai and Kiska, where sea lion trend site counts declined from

. . . Northern Sea Lion

105,289 in 1959 to about 21,000 in 1992 (Fig. 23-3). The decline in Alaska is believed to be due to a combination of incidental kills in fisheries, illegal shooting, changes in the numbers and/or quality of prey, and possibly unidentified factors. The Steller sea lion population off Washington and Oregon is low but stable at about 3,000. In California, they have slowly declined since the 1950's to about 2,000. The 1992 range-wide estimate for this species is 116,000.

Northern Fur Seal

The northern fur seal of the North Pacific Ocean, considered depleted under the MMPA, ranges across subarctic Pacific Rim waters from California to Japan. It numbers 982,000 in U.S. waters. The major U.S. breeding population is on Alaska's Pribilof Islands of St. Paul and St. George. Production on the Pribilof Islands dropped more than 60% between 1955 and 1980, but has since been stable. On St. George Island, production has continued to decline about 6%/year since 1970 (Fig. 23-4). Small U.S. breeding populations are also found on Alaska's Bogoslof Island (1,500), and California's San Miguel Island (6,000).

Figure 23-3.—Estimated population trends of northern (Steller) sea lions in Alaska for the region Kenai to Kiska.

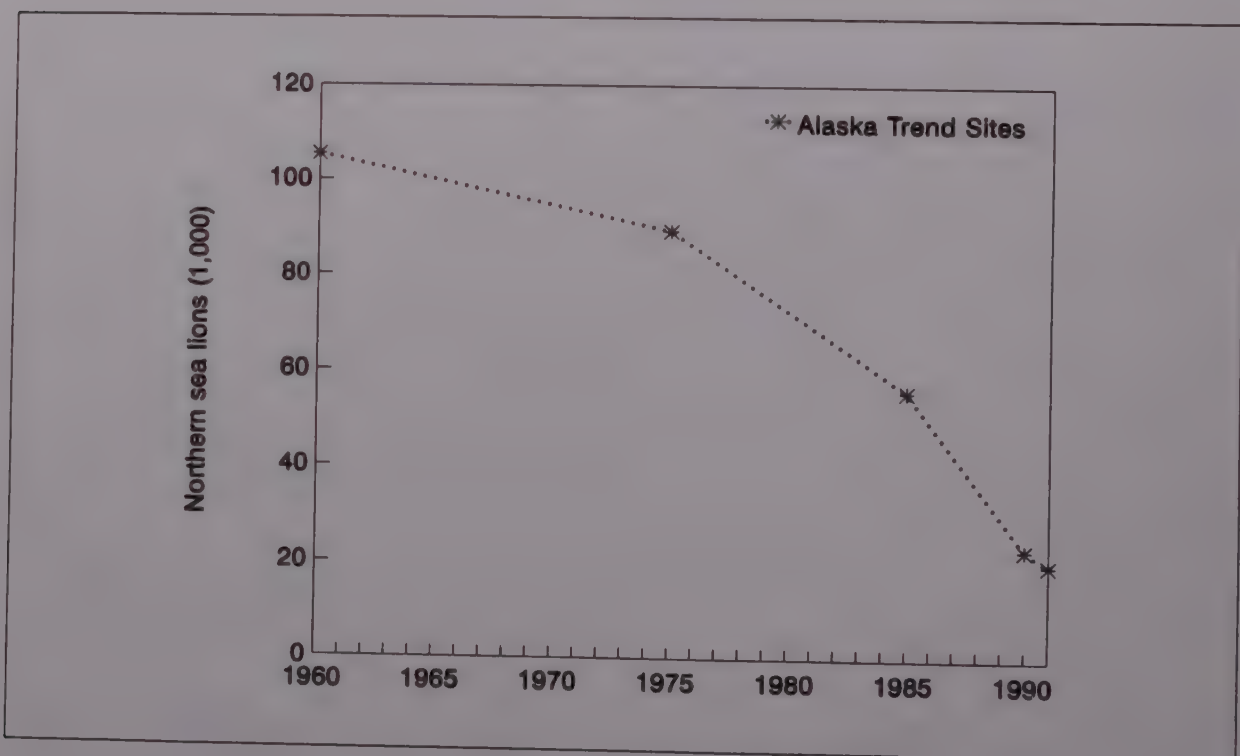
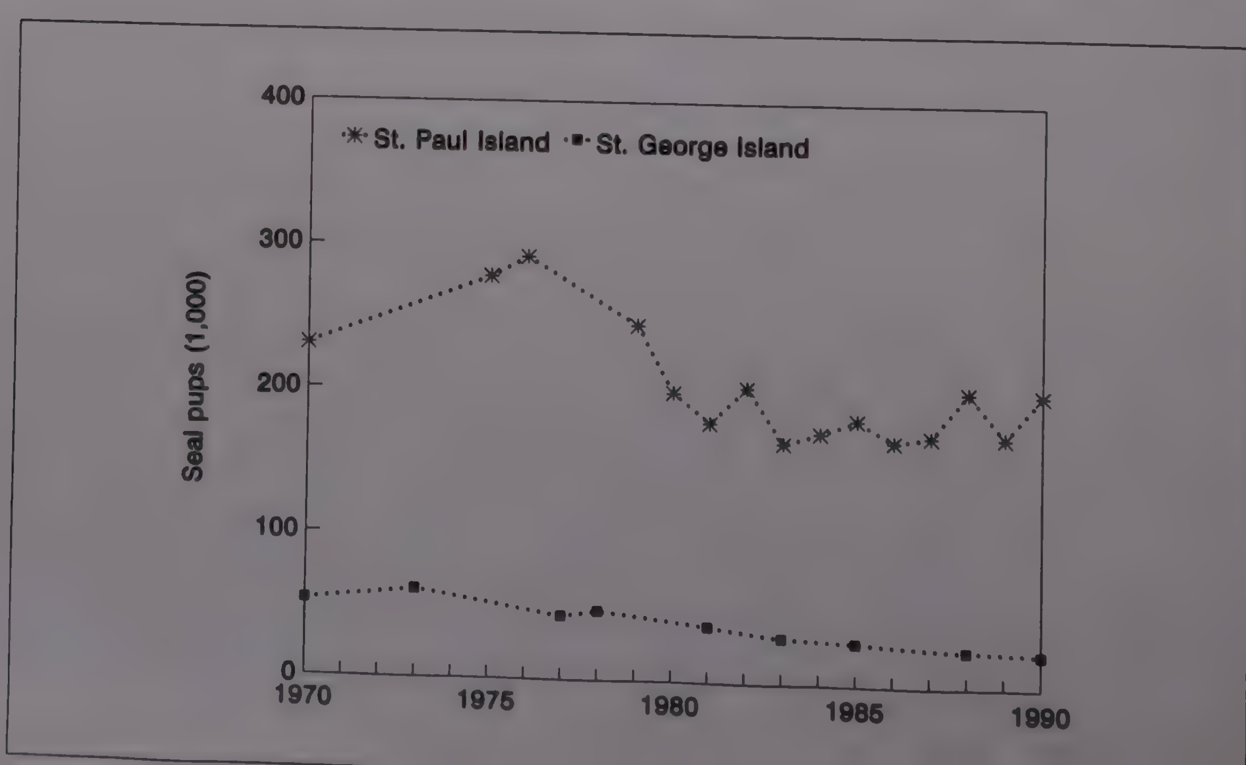


Figure 23-4.—Northern fur seal pup counts on St. Paul and St. George islands, Alaska, 1970-90.

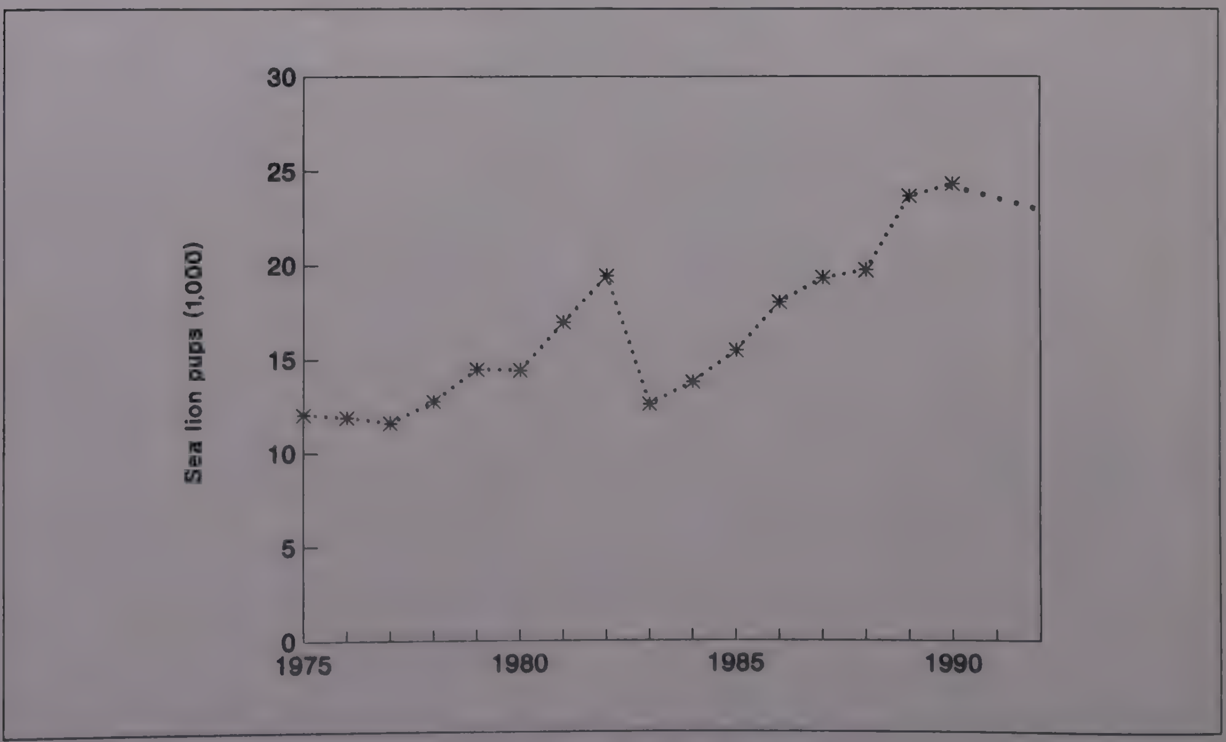


California Sea Lion

There are three subspecies of California sea lion found on the U.S. west coast and British Columbia, in the Galapagos Islands, and in Japan (probably extinct). The breeding range of California sea lions extends from the Channel Islands off the coast of southern California, U.S., to Isla Santa Margarita, on the Pacific coast of Baja California, Mexico, and at various islands located in the Gulf of California, Mexico. Annual U.S. pup production during 1990 exceeded 26,700 pups. The U.S. population is currently increasing at a rate of 10.2% annually (since 1983). In 1990, the U.S. stock had a population size of 111,000. The total population size of the western Baja California stock was estimated at 74,500.

A number of human-related interactions, such as incidental take during fishing operations, entanglement, illegal killing, and pollutants, result in deaths of sea lions. Estimates of California sea lions killed incidentally by commercial setnet and driftnet fishing vessels operating off California were obtained from data collected by scientific observers on fishing vessels, fishing log books, and fish landing receipts. Those estimates ranged from 1,865 sea lions killed in 1991 to 4,288 killed in the fishing year 1986-87. Sea lions have also been observed entangled with monofilament line, gillnet and trawlnet fragments, packing bands, rubber bands, polyfilament rope and line, and other manufactured items. Studies of entanglement rates indicate that entangled animals make up a small proportion of the population. There is also evidence of sea lion mortality resulting from gunshot wounds. These interactions appear to be a result of fishermen shooting the animals when either their gear or their catch was in danger. Studies have been initiated to look at rates of premature births in relation to the level of environmental contaminants and disease agents.

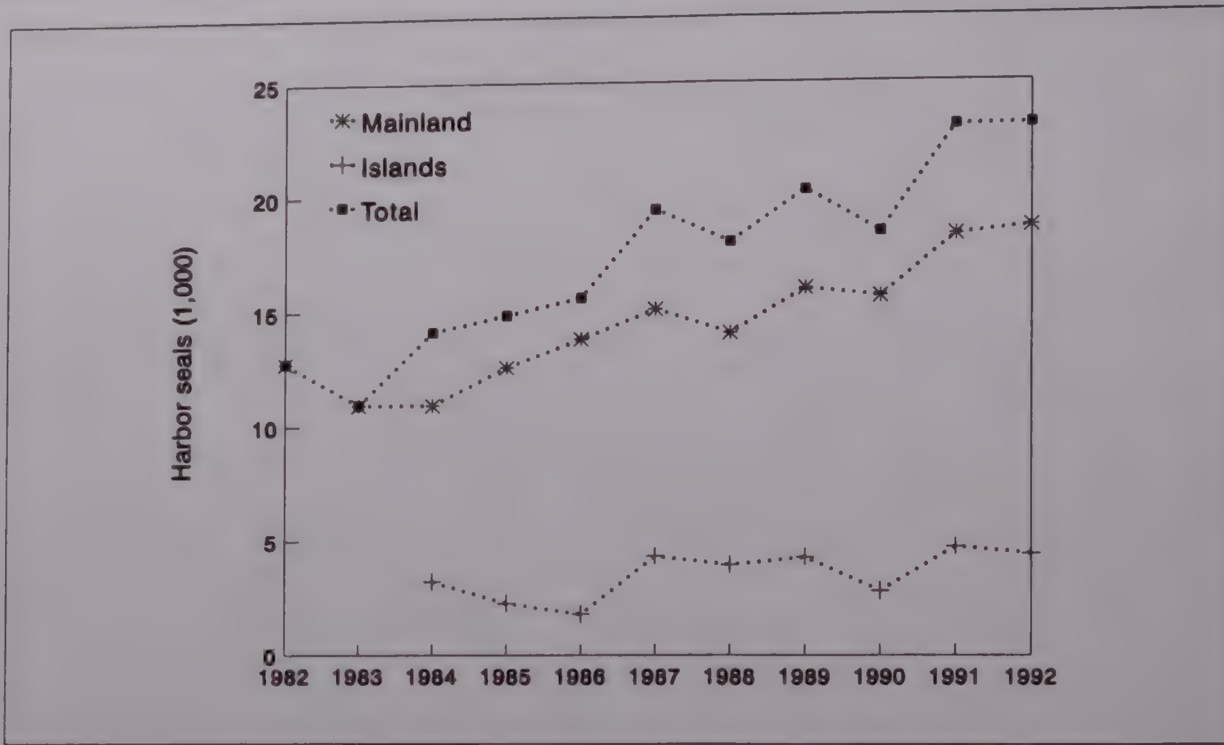
Figure 23-5.—California sea lion pup counts on the Channel Islands, 1975-90, and 1992.



Harbor Seal

The Pacific harbor seal ranges along the west coast of North America from Cedros Island, Baja California, Mexico, northward to western Alaska. In a recent count of harbor seals during their molting period (which is considered to be the time of peak abundance on shore), approximately 23,000 harbor seals were estimated to reside in the Channel Islands and along the California mainland (Fig. 23-6). The population sizes of harbor seals in Oregon and Washington have been estimated at 45,700 seals. Harbor seals in the Gulf of Alaska have declined significantly during the past two decades.

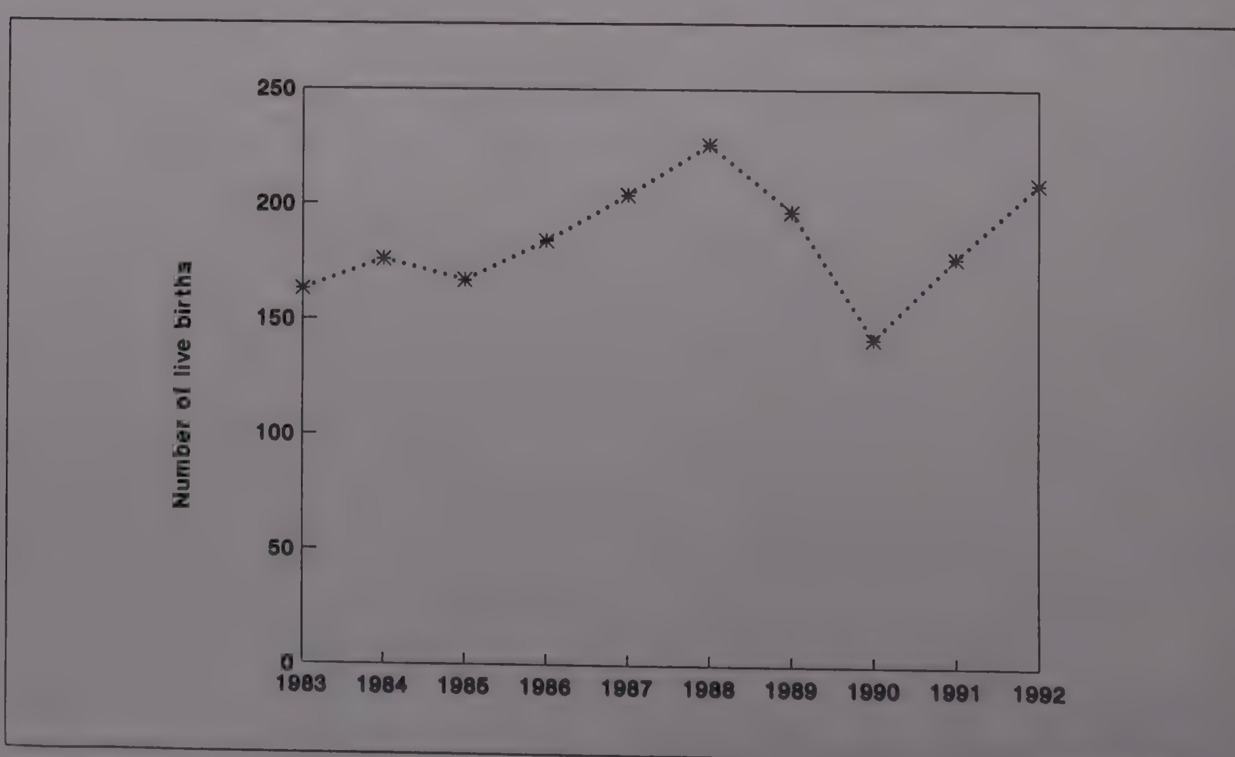
Figure 23-6.—California harbor seal counts, 1982-92.



Hawaiian Monk Seal

The Hawaiian monk seal is limited to the small islands and atolls of the 1,100-mile northwest portion of the Hawaiian Archipelago. This species is listed as endangered under the ESA, due to a decline of approximately 50-60% between the late 1950's and the late 1970's. The largest population is located at French Frigate Shoals, and since 1989 this population has declined by 25-40%. At present, the total population is approximately 1,550. Since 1985, average counts (including pups) at the five main breeding sites peaked at 656 in 1986, but have generally declined since then to a low of 480 in 1991. Pup production during the same period has been highly variable, increasing from 1985 to 1988, declining 35% in 1990, and increasing again in 1991 and 1992 (Fig. 23-7).

Figure 23-7.—Hawaiian monk seal live births, 1983-92.



ISSUES

Studies of marine mammal populations have focused on four primary questions: 1) Have fisheries interactions and other human-related activities directly harmed marine mammals or significantly altered the carrying capacity of the marine ecosystem for them; 2) Are the depleted marine mammals recovering, and have the best steps been taken to speed their recovery; 3) What actions are necessary to minimize potential conflicts between the ESA, MMPA, MFCMA, and other Federal laws on marine resources and fisheries management; and 4) How can marine mammal populations be monitored in the face of environmental variability?

Specific concerns in light of these research issues are discussed below.

Bycatch and Multispecies Interactions

El Niño events in California are often associated with increased interactions between California sea lions and fisheries. This seems to be related to a change in forage conditions for sea lions during El Niño events, where sea lions tend to feed more heavily on fish caught by commercial and recreational fishermen. Given the increased number of California sea lions at this time, the most recent El Niño could result in major problems for west coast fishermen unless methods for minimizing this interaction are developed in the near future.

Another issue involves competition for food. U.S. and foreign commercial fisheries have been operating in the eastern North Pacific for more than 100 years, and fish catches have been sustained there for many decades. Some fish populations, however, have collapsed and are no longer commercially viable, such as the California sardine. The impact of removing millions of fish and shellfish from the marine ecosystem each year on the marine mammals that also depend on them is unknown.

Marine mammals are also incidentally killed in many fisheries. In recent years, the fishery-caused mortality of spotted, spinner, and common dolphins has been reduced dramatically relative to mortality levels in 1986. In 1991, the kill of dolphins in the ETP, expressed as a percentage of population size, was less than 2% for all the stocks. The current population is thought to be able to withstand this level of mortality. Still, incidental mortality in 1991 likely exceeded 20,000 animals. An international regime is currently being developed by nations that purse seine for tunas in the ETP with the goal of eliminating dolphin mortality entirely over the next few years.

The harbor porpoise kill in California's fisheries declined from 200-300/year in the mid-1980's to less than 100/year after gillnet fishing ceased. The harbor porpoise kill by the Makah Indian tribal setnet salmon fishery off the north coast of Washington declined from over 100 in 1987-88 to 13 in 1990 when the fishing effort was reduced.

The known kill of Steller sea lions in Alaska fisheries has declined from over 1,400 in 1982 to 23 in 1990. The numbers killed in other fisheries is believed to be even smaller.

Recovery of Protected Species

Eleven U.S. west coast marine mammal species are listed as endangered or threatened under the ESA. Though the data are limited, right whales in the eastern North Pacific Ocean are believed to be near extinction: only 5-7 sightings have been made in the past 25 years. There are far too few data on other species, such as blue and humpback whales, to judge whether any recovery is taking place. Gray whales have recovered to levels near those estimated for the mid-1800's. California sea lions, northern elephant seals, and harbor seal populations along the west coast are also increasing. Some human activities may, however, be affecting the recovery of some species. For example, adult female humpback whales with calves have apparently been abandoning traditional nearshore calving and calf rearing habitat near Maui, Hawaii, possibly in response to repeated human interference or contact.

In the case of the Hawaiian monk seal, progress in managing the recovery of this species varies among the main breeding populations. At Kure Atoll, with a high level

. . . Recovery of Protected Species

of management intervention, excellent progress is apparent in the increase in number of births from one in 1986 to 14 in 1992. In addition, the management programs have bolstered the immature size classes, and recruitment of females into reproductive age classes is expected to further enhance recovery at this site. The Pearl and Hermes Reef population also appears to be growing and is expected to continue its recovery in the near future.

The largest monk seal population, at French Frigate Shoals, may be near its environmental carrying capacity, in which case further growth would not be expected. Indeed, in the past three years, this population has declined, due to poor juvenile survival and low birth rates triggered by reduced prey availability. Management efforts have been directed toward rehabilitation of juvenile females to enhance their survival and reproductive potential. In addition, the foraging ecology of seals at French Frigate Shoals is being assessed through studies of relative prey abundance over time, as well as seal movement and diving patterns using satellite-linked telemetry.

California sea lion
Zalophus californianus

Populations at Laysan and Lisianski Islands have not grown as expected, and appear to be limited by high mortality of females due to male mobbing behavior, where multiple males simultaneously attempt to mate with a single female. Management has focused on monitoring the occurrence of such behavior and conducting research into mitigation methods. Currently, efforts aim to disassociate offending males from the breeding process by chemically suppressing their testosterone level and aggressive reproductive behavior.

The status of the species as a whole is indicated by the annual mean beach counts of seals and the number of pups born. The total number of births has been highly variable, but without trend since the early 1980's. However, mean counts have fallen since 1985, largely as a result of declines at French Frigate Shoals. Efforts to reverse this trend will continue, through rehabilitation of seals at French Frigate Shoals and elimination of mobbing-related mortality at Laysan and Lisianski Islands.

Recovery plan action will provide a way to gauge progress in the restoration of endangered and threatened resources.

Scientific Advice and Adequacy of Assessments

Some northern pinniped populations, such as Steller sea lion, northern fur seal, and harbor seal, have declined in the last 20 years. During the same period, other pinniped populations farther south along the west coast have increased, such as harbor seal, California sea lion, northern fur seal, and northern elephant seal. Growing marine mammal populations will raise different fishery management concerns. The biological information needed to assess and manage these problems is generally lacking.

Marine mammal populations need to be monitored on a regular basis. However, annual changes in environmental conditions make accurate monitoring difficult. For example, large-scale oceanographic changes associated with El Niño conditions affect the distributions of whales. Because of the expense involved, many of the marine mammal populations are monitored only once every 2-5 years. Generally, precision of marine mammal population estimates are such that changes in population size must be on the order of 20-50% to be detectable, but management advice is often needed before such large changes occur.

Progress

International Dolphin Conservation Act of 1992: Bill H.R. 5419 amended the MMPA to establish a global moratorium to prohibit harvesting of tuna through the use of purse seine nets deployed on or to encircle dolphins or other marine mammals.

Proposed Management Regime for Marine Mammals: The Marine Mammal Protection Act governs the management of marine mammals in the United States. Prior to the 1988 amendments to the MMPA, fisheries could only be granted permits to take marine mammals incidentally if there was scientific evidence to prove that all stocks of marine mammals involved in the fisheries were at or above their optimum sustainable population (OSP) level. However, sufficient evidence regarding the status relative to OSP only exists for a few stocks. Due to problems and economic losses associated with this system of management, the Act was amended in 1988 to allow a 5-year interim exemption period, during which time the incidental taking of marine mammals was permitted in commercial fishing operations. During this time, it was expected that additional information would be gathered on the species involved and on the nature and extent of their interactions with different fisheries. This period ended on 1 October 1993 and a decision will have to be made between the old system or development of a new management scheme for all marine mammals. NMFS is currently collaborating with a number of scientists, conservation organizations, and fisheries experts in order to formulate this new regime which will require the best available information on marine mammal stocks.

UNIT 24 SEA TURTLES

INTRODUCTION

Sea turtles are highly migratory and ply the world's oceans. Under the Endangered Species Act, all marine turtles are listed either as endangered or threatened (Table 24-1). The NMFS has authority to protect and conserve marine turtles in the seas, and the U.S. Fish and Wildlife Service maintains authority while turtles are on land.

The Kemp's ridley, hawksbill, and leatherback turtles are listed as endangered throughout their ranges. The loggerhead and olive ridley turtles are listed as threatened throughout their U.S. ranges, as is the green turtle, except the Florida nesting population which is listed as endangered.

Table 24-1.—Annual number of female sea turtles nesting on U.S. beaches. (Note: Kemp's ridley nests only on one Mexican beach.)

	Number of nesting females			
Area and species	Historic level	Current level	Current trend	Status in U.S.
Atlantic				
Loggerhead	Unknown	20,000-28,000[1]	Stable	T[2]
Green	Unknown	400-500[1]	Increasing	T, E[3]
Kemp's ridley	40,000	700-800[4]	Stable[5]	E
Leatherback	Unknown	Unknown	Unknown	E
Hawksbill	Unknown	Unknown	Declining	E
Pacific				
Loggerhead	Unknown	Unknown	Unknown	T
Green	10,000[6]	450-475[6]	Increasing[7]	T
Olive ridley	Unknown	Unknown	Unknown	T
Leatherback	Unknown	Unknown	Unknown	E
Hawksbill	Unknown	75[8]	Unknown	E

[1]Using 2.5 nests/female.
[2]T = Listed under the Endangered Species Act as threatened.
[3]Listed under the Endangered Species Act as endangered in Florida; threatened in the U.S. Atlantic and Pacific.
[4]Using 1.5 nests/female.
[5]Stable, but critically low.
[6]Historical level for Hawaii only; current level is 1,400 in Hawaii and 100-300 in American Samoa; current level in Guam is unknown.
[7]Trend in Hawaii only, monitored at French Frigate Shoals; however, great concern exists over increasing frequency of fibropapilloma disease in all Hawaiian green turtles.
[8]Estimated total adult population in Hawaii; average number of female hawksbills nesting annually in Hawaii is about 15; current abundance in Guam and American Samoa is unknown.

SPECIES AND STATUS

The Pacific species are loggerhead, green, leatherback, hawksbill, and olive ridley turtles. All are also found in the Atlantic Ocean, but the olive ridley does not commonly enter U.S. waters. In Hawaiian waters, the green and hawksbill are most abundant. Off the U.S. west coast, the loggerhead, leatherback, and olive ridley turtles are most commonly reported.

Green turtle
Chelonia mydas

Historical data on sea turtle numbers are limited. In addition, the length of time that data have been collected has been short when compared with the long life and low reproductive rate of all turtle species. It is difficult to assess the long-term status of sea turtles due to the limited data.

The estimated number of female loggerheads nesting annually in the southeastern United States is about 20,000-28,000 (Table 24-1). Most nest along Florida's east coast where nest numbers have been stable for 5 years. Only about 700-800 female Kemp's ridley turtles nest annually

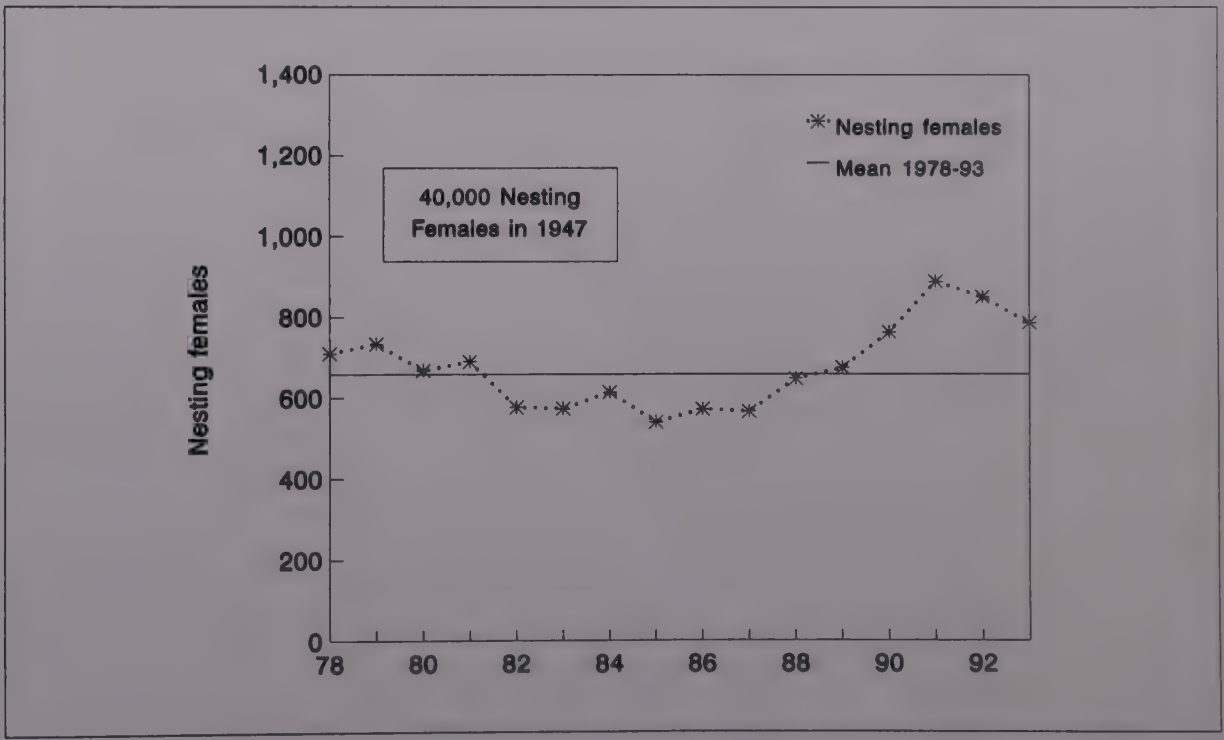
. . . SPECIES AND STATUS

along a limited portion of Mexico's Gulf coast. In 1947, on a single day, 40,000 females were seen nesting on one beach alone. The documented decline in the Kemp's ridley is probably indicative of similar population trends for other sea turtles, though the periods of their various declines may have differed (Fig. 24-1).

Historically, the green sea turtle has supported large fisheries along the Florida and Texas coasts, although its nesting on U.S. beaches has probably always been limited. Currently, perhaps 400-500 green turtles nest annually along the Florida coast. There are no historical estimates for the numbers of hawksbill or leatherback turtles nesting on U.S. Caribbean beaches. The hawksbill has been heavily exploited, and continued trade of products from this species suggests that further declines are possible. The trend over time of the leatherback turtle in U.S. waters is unknown.

Since 1973, Hawaiian surveys of green turtles indicate that the estimated number of turtles nesting annually is about 450-475, and that it is gradually increasing. No accurate historical record of this green turtle population exists. The Hawaiian hawksbill turtle population is very small; only 12-15 nests are recorded each year. In Hawaii, little is known of the species' reproductive biology or population trends.

Figure 24-1.—Number of nesting females of Kemp's ridley sea turtles, 1978-93.



ISSUES

Bycatch and Multispecies Interactions

In the North Pacific there were concerns about sea turtle deaths in the recently concluded high-seas driftnet fisheries. Turtle bycatch rates were monitored on driftnet vessels by U.S., Canadian, Japanese, Korean, and Taiwanese scientific observers. The effect of these driftnet fisheries on U.S. sea turtle populations is unknown, but a moratorium on high-seas driftnet fisheries is now in place under a United Nations resolution.

Turtles are also killed incidentally in various commercial fisheries. Turtles are caught and killed in pelagic longline fisheries targeting tunas and billfishes. Conservatively, as many as 11,000 sea turtles may have been killed annually in offshore shrimp trawls. Turtle mortality from inshore shrimp trawling was not estimated. Fortunately, turtle excluder devices (TED's) have been developed for shrimp and fish trawls. TED's enable turtles to escape the trawl net and prevent them from drowning. These devices reduce the turtle kill by shrimp trawls by 97% and studies indicate that the use of TED's minimally reduces shrimp catches. TED use is presently mandated for most of the Atlantic and Gulf of Mexico shrimp and summer flounder trawl fisheries.

Habitat Concerns

Coastal development is reducing nesting, egg incubation, and foraging habitats. Floating tar balls and plastics, if eaten, can harm or kill sea turtles. The magnitude of these problems is not fully known, but they occur worldwide, and international cooperation for marine turtle protection and recovery is required.

Progress

Pacific: The recovery of endangered and threatened marine turtle populations in the North Pacific will be enhanced by the United Nations-sponsored moratorium on large-scale driftnet fishing that went into effect on 1 January 1993. During 1990 and 1991, when the high-seas driftnet fisheries were carefully monitored by NMFS and cooperating foreign fishery agencies, data were collected that have led to a better understanding of the pelagic distribution and ecology of sea turtles in the North Pacific.

In the Hawaii pelagic longline fishery for tuna and swordfish, the incidental catch of turtles is being closely monitored through a compulsory logbook program. A scientific observer program is being considered as a means to collect the more detailed data required to verify logbook reports and assess turtle impacts. During late 1993, a workshop was held to formulate research techniques to determine hooking and entanglement mortality of turtles incidentally caught by longline.

Significant progress is being made in the monitoring of Hawaiian green turtles. In 1992, a 5-year series of saturation surveys was completed at East Island, French Frigate Shoals, the principal location of Hawaiian green turtle nesting, by NMFS and the U.S. Fish and Wildlife Service. Based on these surveys, rigorous quantitative methods have been developed for annual nesting surveys at East Island. Progress is also being made in monitoring juvenile and subadult Hawaiian green turtles in their nearshore habitat. A vigorous research program is underway to study the origins and effects of fibropapilloma tumor disease in the Hawaiian green turtle population; progress has been made in developing information relevant to potential etiologies involving cardiovascular parasites, viruses, and environmental pollutants. A similar disease situation exists among green turtles in Florida and the Caribbean.

Atlantic: The joint NMFS/USFWS Atlantic Sea Turtle Recovery Plans have been developed, finalized, and approved. These plans prioritize turtle research requirements and delineate reasonable actions which are believed to be required to recover and/or protect the species.

A major factor affecting the recovery of turtle populations is the mitigation of commercial fishing/sea turtle interactions. The incidental capture of sea turtles in various commercial fisheries has been studied and summarized and was the focal point of a meeting at the recent 13th Annual Sea Turtle Symposium. Recent legislation has allowed NMFS to use observers in selected fisheries to document the occurrence of incidental turtle captures. Also, several new TED models have been recently tested and approved for commercial use, and research continues on the development of a new TED design which would accommodate small inshore turtles.

Considerable progress has been made concerning inshore juvenile developmental habitat research and remote sensing. NMFS research projects have been started on juvenile ridleys and greens in the Cedar Keys and Biscayne Bay, Florida, and in the northwestern Gulf of Mexico. Additionally, a comprehensive research project concerning the incidence, etiology, and epidemiology of fibropapilloma tumor disease in Atlantic green turtles has been started. Concern is growing that this disease may seriously affect the recovery of world-wide green turtle populations.

Part 3: APPENDICES

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APPENDIX 2 PRINCIPAL FACILITIES OF THE NATIONAL MARINE FISHERIES SERVICE

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Gloucester, MA 01930
(508) 281-9300

Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543
(508) 548-5123

Woods Hole Laboratory
Woods Hole, MA

Narragansett Laboratory
Narragansett, RI

Milford Laboratory
Milford, CT

Sandy Hook Laboratory
Highlands, NJ

Oxford Laboratory
Oxford, MD

Gloucester Laboratory
Gloucester, MA

National Systematics Laboratory
Washington, DC

Southeast Regional Office
9450 Koger Blvd.
St. Petersburg, FL 33702
(813) 893-3141

Southeast Fisheries Science Center
75 Virginia Beach Dr.
Miami, FL 33149
(305) 361-4225

Miami Laboratory
Miami, FL

Mississippi Laboratories
Pascagoula, MS

Panama City Laboratory
Panama City, FL

Galveston Laboratory
Galveston, TX

Charleston Laboratory
Charleston, SC

Beaufort Laboratory
Beaufort, NC

Northwest Regional Office
7600 Sand Point Way N.E.
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Seattle, WA 98115
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Northwest Fisheries Science Center
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Seattle, WA 98112
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Kodiak Investigations–Utilization
Kodiak, AK

Southwest Regional Office
501 W. Ocean Blvd.
Long Beach, CA 90802
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Southwest Fisheries Science Center
P.O. Box 271
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La Jolla, CA 92038
(619) 546-7000

La Jolla Laboratory
La Jolla, CA

Honolulu Laboratory
Honolulu, HI

Tiburon Laboratory
Tiburon, CA

Pacific Fisheries Environmental Group
Monterey, CA

Alaska Regional Office
P.O. Box 21668
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Juneau, AK 99802
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Alaska Fisheries Science Center
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Seattle, WA 98115
(206) 526-4000

National Marine Mammal Laboratory
Seattle, WA

Auke Bay Laboratory
Auke Bay, AK

Kodiak Investigations—Research
Kodiak, AK

Seattle Laboratory
Seattle, WA

APPENDIX 3 FISHERY MANAGEMENT COUNCILS AND FISHERY MANAGEMENT PLANS

NEW ENGLAND FISHERY MANAGEMENT COUNCIL	American Lobster Fishery Management Plan Fishery Management Plan for the Northeast Multispecies Fishery	Fishery Management Plan for Atlantic Sea Scallops Atlantic Salmon Fishery Management Plan
MID-ATLANTIC FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for Atlantic Mackerel, Squid, and Butterfish Fisheries Fishery Management Plan for Atlantic Surf Clam and Ocean Quahog Fisheries	Fishery Management Plan for Atlantic Bluefish Fishery Management Plan for Summer Flounder
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region	Atlantic Coast Red Drum Fishery Management Plan
GULF OF MEXICO FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for the Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico Fishery Management Plan for Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic	Fishery Management Plan for Coral and Coral Reefs in the Gulf of Mexico and South Atlantic Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico Fishery Management Plan for the Red Drum Fishery of the Gulf of Mexico
CARIBBEAN FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands	Fishery Management Plan for the Shallow Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands
PACIFIC FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for the Groundfish Fishery off Washington, Oregon, and California Northern Anchovy Fishery Management Plan	Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California
WESTERN PACIFIC FISHERY MANAGEMENT COUNCIL	Fishery Management Plan for the Crustacean Fishery of the Western Pacific Region Fishery Management Plan for the Precious Corals Fisheries of the Western Pacific Region	Fishery Management Plan for the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region

NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for Groundfish of the Gulf of Alaska

Fishery Management Plan for the High Seas Salmon Fishery off the Coast of Alaska East of 175 Degrees East Longitude

Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area

Bering Sea/Aleutian Islands King and Tanner Crab Fishery Management Plan

SECRETARIAL PLANS

Fishery Management Plan for Atlantic Swordfish

Fishery Management Plan for Atlantic Billfishes

Fishery Management Plan for Sharks of the Atlantic Ocean

LIST OF FMP AMENDMENTS IMPLEMENTED 1 OCTOBER 1992 THROUGH 30 SEPTEMBER 1993

FMP for the Pelagic Fisheries of the Western Pacific Region; Amendment 6.
Final rule published 10/27/92; 57 FR 48564.

Added tunas and related species to the fishery management unit. Waters in the EEZ that were closed to domestic longline vessels to prevent gear conflicts and incidental take of protected species were also closed to operators of foreign vessels fishing for pelagic species. Some of the general foreign fishing regulations and reporting requirements that applied to foreign longline vessels were also applied to foreign baitboat and purse seine vessels.

FMP for the Pacific Coast Groundfish Fishery; Amendment 6.
Final rule published 11/16/92; 57 FR 54001.

Established a license-limitation limited entry program for the commercial groundfish fishery based on the issuance of gear-specific Federal permits to promote conservation and improve stability and economic viability of the fishing industry, by limiting or reducing harvesting capacity in the Pacific coast groundfish fishery.

FMP for the Summer Flounder Fishery; Amendment 2.
Final rule published 12/4/92; 57 FR 57358.

Established annual quotas for the commercial fishery allocated on a state-by-state basis; minimum mesh size for trawl gear; a seasonal restriction for the recreational fishery; bag limits on a trip basis for the recreational fishery; minimum fish size requirements for the commercial and recreational fisheries; a 5-year moratorium on entry into the commercial fishery; permits for dealers wanting to purchase summer flounder; mandatory logbook reporting by permitted dealers; a prohibition on sale of summer flounder caught by the recreational fishery; and authorization to collect application fees for vessel and dealer permits. The amendment also contained measures designed to protect endangered and threatened sea turtles, especially to reduce the likelihood of incidental catch or injury to sea turtles in the winter trawl fishery for summer flounder.

FMP for the Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic; Amendment 6.
Final rule published 12/9/92; 57 FR 58151.

Allowed the earned income requirement for a commercial vessel permit for king or Spanish mackerel to be met in any one of the 3 years preceding the permit application; changed the fishing year for recreational bag limits to the calendar year; removed the provisions for reducing a recreational bag limit to zero during a fishing year; increased the minimum size limit for king mackerel to 20 inches (50.8 cm); implemented commercial vessel trip limits for Atlantic migratory group Spanish mackerel; and made other corrections and

. . . LIST OF FMP AMENDMENTS IMPLEMENTED 1 OCTOBER 1992 THROUGH 30 SEPTEMBER 1993

clarifications to the regulations to conform them to current usage. In addition, Amendment 6 revised the problems and objectives of the FMP; specified periods for rebuilding overfished stocks; changed the required frequency of stock assessments from annual to biennial; added to the management measures that may be implemented or modified by the framework procedure; and provided for the establishment of separate subgroups and allocations of the Gulf migratory group of king mackerel, divided at the Florida/Alabama boundary, when the assessment panel is able to provide ranges of acceptable biological catch for the subgroups.

FMP for Groundfish of the Gulf of Alaska; Amendment 26.
Notice of approval published 12/28/92; 57 FR 61585.

Continued the authorization of time/area closures around Kodiak Island to protect king and Tanner crab habitat areas and to promote the recovery of these crab stocks.

FMP for Groundfish of the Bering Sea and Aleutian Islands Area; Amendment 21.
Final rule published 3/18/93; 58 FR 14524.

Established authority for setting Pacific halibut bycatch mortality limits for trawl and nontrawl gear fisheries in the Bering Sea and Aleutian Islands Area.

FMP for the Shrimp Fishery of the Gulf of Mexico; Amendment 6.
Final rule published 4/1/93; 58 FR 17169.

Seasonally modified the boundary of the Tortugas shrimp sanctuary to reduce the area closed to trawl fishing to enable fishermen to harvest marketable-sized shrimp during specified periods from three small areas that otherwise would be closed.

FMP for the Pacific Coast Groundfish Fishery; Amendment 7.
Final rule published 4/20/93; 58 FR 21263.

Authorized the imposition of management measures on the Pacific coast groundfish fishery to reduce the bycatch of salmon and other nongroundfish species. Under Amendment 7, regulations could be issued to reduce mortality of nongroundfish species when a conservation issue has been identified or in response to requirements of the Endangered Species Act or other applicable law.

FMP for Sharks of the Atlantic Ocean.
Final rule published 4/26/93; 58 FR 21931.

Divided the 39 shark species managed by the FMP into three groups for management and resource assessment; required annual permits for commercial shark fishing vessels fishing in the U.S. exclusive economic zone (EEZ); required data reports from owners/operators of permitted vessels and persons conducting shark fishing tournaments; required permitted vessels to accommodate NMFS-approved observers upon request; established a fishing year of 1 January through 31 December; prohibited "finning," the practice of harvesting sharks for fins alone; required sharks not retained by fishermen to be released in a manner ensuring maximum probability of survival; established recreational bag limits for sharks; established annual and semiannual quotas for commercial landings of the large coastal and pelagic species groups and provided for commercial fishery closures when the species group quotas are reached; limited the sale of sharks harvested from the EEZ to those caught from permitted vessels; authorized the Assistant Administrator for Fisheries, NOAA, to implement or adjust certain management measures in accordance with a specified framework regulatory adjustment procedure; and reduced the total allowable level of foreign fishing in the EEZ for the managed shark species to zero.

. . . LIST OF FMP AMENDMENTS IMPLEMENTED 1 OCTOBER 1992 THROUGH 30 SEPTEMBER 1993

FMP for the Reef Fish Fishery of the Gulf of Mexico; Amendment 6.
Final rule published 6/15/93; 58 FR 33025.

Continued, through 31 December 1994, the vessel trip limits for red snapper of 2,000 pounds (907 kg) for a vessel that has a red snapper endorsement on its reef fish permit and 200 pounds (91 kg) for a permitted vessel without such endorsement.

FMP for Groundfish of the Gulf of Alaska; Amendment 28.
Final rule published 7/13/93; 58 FR 37660.

Established three new management districts in the Aleutian Islands subarea.

FMP for the Summer Flounder Fishery; Amendment 3.
Final rule published 7/27/93; 58 FR 40072.

Increased the amount of summer flounder that may be on board an otter trawl vessel from November 1 through April 30 before becoming subject to the minimum mesh size requirement from less than 100 pounds (45.4 kg) to less than 200 pounds (90.8 kg); revised the boundary of the seasonal fishing area exempt from the minimum mesh size requirement; and implemented a framework measure to adjust the boundary and season of the exemption area. The intent is to enhance compliance with and enforcement of the minimum mesh size requirement, and to minimize the potential for excessive discards of legal-sized summer flounder.

FMP for the Summer Flounder Fishery; Amendment 4.
Final rule published 9/24/93; 58 FR 49937.

Revises the percentage of the commercial quota allocated to each state, and revises the manner in which 1994 state quotas will be adjusted for quota overages that may occur in 1993. The intent is to adjust for the underreporting of Connecticut catch data used to establish allocation shares and to make additional quota available to commercial vessels landing summer flounder in Connecticut.

APPENDIX 4 COMMON AND SCIENTIFIC NAMES OF SPECIES COVERED IN THIS REPORT[1]

UNIT 1: NORTHEAST DEMERSAL FISHERIES

Principal Groundfish and Flounders
- Atlantic cod, *Gadus morhua*
- Haddock, *Melanogrammus aeglefinus*
- Pollock, *Pollachius virens*
- Redfish, *Sebastes* spp.
- Silver hake, *Merluccius bilinearis*
- Red hake, *Urophycis chuss*
- Yellowtail flounder, *Pleuronectes ferrugineus*
- Winter flounder, *Pseudopleuronectes americanus*
- Summer flounder, *Paralichthys dentatus*
- Witch flounder, *Glyptocephalus cynoglossus*
- American plaice, *Hippoglossoides platessoides*
- Windowpane, *Scophthalmus aquosus*

Skates and Spiny Dogfish
- Spiny dogfish, *Squalus acanthias*
- Little skate, *Raja erinacea*
- Winter skate, *R. ocellata*
- Barndoor skate, *R. laevis*
- Thorny skate, *R. radiata*
- Brier skate, *R. eglanteria*
- Leopard skate, *R. garmani*
- Smooth-tailed skate, *R. senta*

Other Finfish
- White hake, *Urophycis tenuis*
- Goosefish, *Lophius americanus*
- Cusk, *Brosme brosme*
- Ocean pout, *Macrozoarces americanus*
- Sculpins, Family Cottidae
- Searobins, Family Triglidae
- Scup, *Stenotomus chrysops*
- Tilefish, *Lopholatilus chamaeleonticeps*
- Wolffishes, *Anarhichas* spp.
- Atlantic argentine, *Argentina silus*
- Black sea bass, *Centropristis striata*
- Smooth dogfish, *Mustelus canis*
- Spot, *Leiostomus xanthurus*
- Weakfish, *Cynoscion regalis*
- Atlantic halibut, *Hippoglossus hippoglossus*

UNIT 2: NORTHEAST PELAGIC FISHERIES

- Atlantic (sea) herring, *Clupea harengus*
- Atlantic mackerel, *Scomber scombrus*
- Butterfish, *Peprilus triacanthus*
- Bluefish, *Pomatomus saltatrix*
- Long-finned squid, *Loligo pealei*
- Short-finned squid, *Illex illecebrosus*

UNIT 3: ATLANTIC ANADROMOUS FISHERIES

- Atlantic salmon, *Salmo salar*
- American shad, *Alosa sapidissima*
- River herring (alewife), *Alosa pseudoharengus*
- Striped bass, *Morone saxatilis*
- Atlantic sturgeon, *Acipenser oxyrhynchus*
- Blueback herring, *Alosa aestivalis*
- Shortnose sturgeon, *Acipenser brevirostrum*
- Rainbow smelt, *Osmerus mordax*

UNIT 4: NORTHEAST INVERTEBRATE FISHERIES

- Sea scallop, *Placopecten magellanicus*
- American lobster, *Homarus americanus*
- Surfclam, *Spisula solidissima*
- Ocean quahog, *Arctica islandica*
- Northern shrimp, *Pandalus borealis*

UNIT 5: ATLANTIC HIGHLY MIGRATORY PELAGIC FISHERIES

Swordfish, *Xiphias gladius*

Billfishes
- Sailfish, *Istiophorus platypterus*
- Blue marlin, *Makaira nigricans*
- White marlin, *Tetrapturus albidus*
- Longbill spearfish, *Tetrapturus pfluegeri*
- Atlantic bluefin tuna, *Thunnus thynnus*

Other Tunas
- Albacore, *Thunnus alalunga*
- Bigeye tuna, *Thunnus obesus*
- Blackfin tuna, *Thunnus atlanticus*
- Yellowfin tuna, *Thunnus albacares*
- Little tunny, *Euthynnus alletteratus*
- Skipjack tuna, *Katsuwonus pelamis*
- Bullet tuna, *Auxis rochei*
- Frigate tuna, *Auxis thazard*

[1]Species are listed by the Unit in which they are found. Not all are mentioned in the text since many are grouped together for management purposes under one category (i.e, pelagic fishery, groundfish fishery).

UNIT 6: ATLANTIC SHARK FISHERIES

Pelagic Sharks
- Thresher shark, *Alopias vulpinus*
- Bigeye thresher, *Alopias superciliosus*
- Oceanic whitetip shark, *Carcharhinus longimanus*
- Sevengill shark, *Heptrachias perlo*
- Sixgill shark, *Hexanchus griseus*
- Bigeye sixgill shark, *Hexanchus vitulus*
- Shortfin mako, *Isurus oxyrinchus*
- Longfin mako, *Isurus paucus*
- Porbeagle, *Lamna nasus*
- Blue shark, *Prionace glauca*

Large Coastal Sharks
- Sandbar shark, *Carcharhinus plumbeus*
- Reef shark, *Carcharhinus perezi*
- Blacktip shark, *Carcharhinus limbatus*
- Dusky shark, *Carcharhinus obscurus*
- Spinner shark, *Carcharhinus brevipinna*
- Silky shark, *Carcharhinus falciformis*
- Bull shark, *Carcharhinus leucas*
- Bignose shark, *Carcharhinus altimus*
- Galapagos shark, *Carcharhinus galapagensis*
- Night shark, *Carcharhinus signatus*
- White shark, *Carcharodon carcharias*
- Basking shark, *Cetorhinus maximus*
- Tiger shark, *Galeocerdo cuvier*
- Nurse shark, *Ginglymostoma cirratum*
- Lemon shark, *Negaprion brevirostris*
- Ragged-tooth shark, *Odontaspis ferox*
- Whale shark, *Rhincodon typus*
- Scalloped hammerhead, *Sphyrna lewini*
- Great hammerhead, *Sphyrna mokarran*
- Smooth hammerhead, *Sphyrna zygaena*

Small Coastal Sharks
- Finetooth shark, *Carcharhinus isodon*
- Blacknose shark, *Carcharhinus acronotus*
- Atlantic sharpnose shark, *Rhizoprionodon terraenovae*
- Caribbean sharpnose shark, *Rhizoprionodon porosus*
- Bonnethead, *Sphyrna tiburo*
- Atlantic angel shark, *Squatina dumeril*

UNIT 7: ATLANTIC/GULF OF MEXICO COASTAL PELAGIC FISHERIES

- King mackerel (Atlantic/Gulf), *Scomberomorus cavalla*
- Spanish mackerel (Atlantic/Gulf), *Scomberomorus maculatus*
- Cobia, *Rachycentron canadum*
- Cero (mackerel), *Scomberomorus regalis*
- Dolphin, *Coryphaena hippurus*

UNIT 8: ATLANTIC/GULF OF MEXICO/CARIBBEAN REEF FISH FISHERIES

- Black snapper, *Apsilus dentatus*
- Queen snapper, *Etelis oculatus*
- Mutton snapper, *Lutjanus analis*
- Schoolmaster, *Lutjanus apodus*
- Blackfin snapper, *Lutjanus buccanella*
- Red snapper, *Lutjanus campechanus*
- Cubera snapper, *Lutjanus cyanopterus*
- Gray snapper, *Lutjanus griseus*
- Mahogany snapper, *Lutjanus mahogoni*
- Dog snapper, *Lutjanus jocu*
- Lane snapper, *Lutjanus synagris*
- Silk snapper, *Lutjanus vivanus*
- Yellowtail snapper, *Ocyurus chrysurus*
- Vermilion snapper, *Rhomboplites aurorubens*
- Wenchman, *Pristipomoides aquilonaris*
- Voraz, *Pristipomoides macrophthalmus*
- Bank sea bass, *Centropristis ocyurus*
- Rock sea bass, *Centropristis philadelphica*
- Black sea bass, *Centropristis striata*
- Dwarf sand perch, *Diplectrum bivittatum*
- Sand perch, *Diplectrum formosum*
- Rock hind, *Epinephelus adscensionis*
- Graysby, *Epinephelus cruentatus*
- Speckled hind, *Epinephelus drummondhayi*
- Yellowedge grouper, *Epinephelus flavolimbatus*
- Coney, *Epinephelus fulvus*
- Red hind, *Epinephelus guttatus*
- Jewfish, *Epinephelus itajara*
- Red grouper, *Epinephelus morio*
- Misty grouper, *Epinephelus mystacinus*
- Warsaw grouper, *Epinephelus nigritus*
- Snowy grouper, *Epinephelus niveatus*
- Nassau grouper, *Epinephelus striatus*
- Black grouper, *Mycteroperca bonaci*
- Yellowmouth grouper, *Mycteroperca interstitialis*

. . . ATLANTIC/GULF OF MEXICO/CARIBBEAN REEF FISH FISHERIES

Gag, *Mycteroperca microlepis*
Scamp, *Mycteroperca phenax*
Tiger grouper, *Mycteroperca tigris*
Yellowfin grouper, *Mycteroperca venenosa*
Wreckfish, *Polyprion americanus*
Sheepshead, *Archosargus probatocephalus*
Sea bream, *Archosargus rhomboidalis*
Grass porgy, *Calamus arctifrons*
Jolthead porgy, *Calamus bajonado*
Saucereye porgy, *Calamus calamus*
Whitebone porgy, *Calamus leucosteus*
Knobbed porgy, *Calamus nodosus*
Sheepshead porgy, *Calamus penna*
Pluma, *Calamus pennatula*
Littlehead porgy, *Calamus proridens*
Pinfish, *Lagodon rhomboides*
Red porgy, *Pagrus pagrus*
Longspine porgy, *Stenotomus caprinus*
Scup, *Stenotomus chrysops*
Black margate, *Anisotremus surinamensis*
Porkfish, *Anisotremus virginicus*
Margate, *Haemulon album*
Tomtate, *Haemulon aurolineatum*
Smallmouth grunt, *Haemulon chrysargyreum*
French grunt, *Haemulon flavolineatum*
Spanish grunt, *Haemulon macrostomum*
Cottonwick, *Haemulon melanurum*
Sailors choice, *Haemulon parra*
White grunt, *Haemulon plumieri*
Bluestriped grunt, *Haemulon sciurus*
Pigfish, *Orthopristis chrysoptera*
Goldface tilefish, *Caulolatilus chrysops*
Blackline tilefish, *Caulolatilus cyanops*
Anchor tilefish, *Caulolatilus intermedius*
Blueline (grey) tilefish, *Caulolatilus microps*
Tilefish (golden), *Lopholatilus chamaeleonticeps*
Sand tilefish, *Malacanthus plumieri*
Gray triggerfish, *Balistes capriscus*
Queen triggerfish, *Balistes vetula*
Ocean triggerfish, *Canthidermis sufflamen*
Black durgon, *Melichthys niger*
Sargassum triggerfish, *Xanthichthys ringens*
Spanish hogfish, *Bodianus rufus*
Hogfish, *Lachnolaimus maximus*
Puddingwife, *Halichoeres radiatus*
Pearly razorfish, *Hemipteronotus novacula*
Yellow jack, *Caranx bartholomaei*
Blue runner, *Caranx crysos*
Crevalle jack, *Caranx hippos*
Horse-eye jack, *Caranx latus*
Black jack, *Caranx lugubris*
Bar jack, *Caranx ruber*
Greater amberjack, *Seriola dumerili*
Lesser amberjack, *Seriola fasciata*
Almaco jack, *Seriola rivoliana*
Squirrelfish, *Holocentrus adscensionis*
Longspine squirrelfish, *Holocentrus rufus*
Yellow goatfish, *Mulloidichthys martinicus*
Spotted goatfish, *Pseudopeneus maculatus*
Foureye butterflyfish, *Chaetodon capistratus*
Spotfin butterflyfish, *Chaetodon ocellatus*
Banded butterflyfish, *Chaetodon striatus*
Queen angelfish, *Holacanthus ciliaris*
Rock beauty, *Holacanthus tricolor*
Gray angelfish, *Pomacanthus arcuatus*
French angelfish, *Pomacanthus paru*
Midnight parrotfish, *Scarus coelestinus*
Blue parrotfish, *Scarus coeruleus*
Striped parrotfish, *Scarus croicensis*
Rainbow parrotfish, *Scarus quacamaia*
Princess parrotfish, *Scarus taeniopterus*
Queen parrotfish, *Scarus vetula*
Redband parrotfish, *Sparisoma aurofrenatum*
Redtail parrotfish, *Sparisoma chrysopterum*
Stoplight parrotfish, *Sparisoma viride*
Ocean surgeonfish, *Acanthurus bahianus*
Doctorfish, *Acanthurus chirurgus*
Blue tang, *Acanthurus coeruleus*
Spotted trunkfish, *Lactophrys bicaudalis*
Honeycomb cowfish, *Lactophrys polygonia*
Scrawled cowfish, *Lactophrys quadricornis*
Trunkfish, *Lactophrys trigonus*
Smooth trunkfish, *Lactophrys triqueter*

UNIT 9: SOUTHEAST DRUM AND CROAKER FISHERIES	Red drum, *Sciaenops ocellatus* Spotted seatrout, *Cynoscion nebulosus* Silver seatrout, *Cynoscion nothus* Sand seatrout, *Cynoscion arenarius* Spot, *Leiostomus xanthurus* Atlantic croaker, *Micropogonias undulatus*	Black drum, *Pogonias cromis* Southern kingfish, *Menticirrhus americanus* Gulf kingfish, *Menticirrhus littoralis* Northern kingfish, *Menticirrhus saxatilis*
UNIT 10: SOUTHEAST MENHADEN AND BUTTERFISH FISHERIES	Atlantic menhaden, *Brevoortia tyrannus* Gulf menhaden, *Brevoortia patronus*	Gulf butterfish, *Peprilus burti*
UNIT 11: SOUTHEAST/ CARIBBEAN INVER-TEBRATE FISHERIES	Spiny Lobsters/Stone Crabs Spiny lobster (SE/Caribbean), *Panulirus argus* Slipper lobster, *Scyllarides nodifer* Stone crab, *Menippe mercenaria* Shrimp Brown shrimp, *Penaeus aztecus* White shrimp, *Penaeus setiferus*	Pink shrimp, *Penaeus duorarum* Royal red shrimp, *Hymenopenaeus robustus* Seabobs, *Xiphopenaeus kroyeri* Rock shrimp, *Sicyonia brevirostris* Others Queen conch, *Strombus gigas* Corals
UNIT 12: PACIFIC COAST SALMON FISHERIES	Chinook salmon, *Oncorhynchus tshawytscha* Coho salmon, *Oncorhynchus kisutch*	Pink salmon, *Oncorhynchus gorbuscha* Sockeye salmon, *Oncorhynchus nerka* Chum salmon, *Oncorhynchus keta*
UNIT 13: ALASKA SALMON FISHERIES	Chinook salmon, *Oncorhynchus tshawytscha* Coho salmon, *Oncorhynchus kisutch*	Pink salmon, *Oncorhynchus gorbuscha* Sockeye salmon, *Oncorhynchus nerka* Chum salmon, *Oncorhynchus keta*
UNIT 14: PACIFIC COAST AND ALASKA PELAGIC FISHERIES	Northern anchovy, *Engraulis mordax* Pacific herring (Alaska), *Clupea harengus pallasi* Pacific (California) sardine, *Sardinops sagax*	Jack mackerel, *Trachurus symmetricus* Chub (Pacific) mackerel, *Scomber japonicus*
UNIT 15: PACIFIC COAST GROUNDFISH FISHERIES	Pacific hake (whiting), *Merluccius productus* Sablefish (black cod), *Anoplopoma fimbria* Dover sole, *Microstomus pacificus* Thornyheads Shortspine thornyhead, *Sebastolobus alascanus*	Longspine thornyhead, *Sebastolobus altivelis* Rockfish Aurora rockfish, *Sebastes aurora* Bank rockfish, *Sebastes rufus* Black-and-yellow rockfish, *Sebastes chrysomelas*

. . . PACIFIC COAST GROUNDFISH FISHERIES

Rockfish (cont.)
- Blackgill rockfish, *Sebastes melanostomus*
- Blue rockfish, *Sebastes mystinus*
- Bocaccio, *Sebastes paucispinis*
- Bronzespotted rockfish, *Sebastes gilli*
- Brown rockfish, *Sebastes auriculatus*
- Calico rockfish, *Sebastes dalli*
- Canary rockfish, *Sebastes pinniger*
- Chilipepper, *Sebastes goodei*
- China rockfish, *Sebastes nebulosus*
- Copper rockfish, *Sebastes caurinus*
- Cowcod, *Sebastes levis*
- Darkblotched rockfish, *Sebastes crameri*
- Dusky rockfish, *Sebastes ciliatus*
- Flag rockfish, *Sebastes rubrivinctus*
- Gopher rockfish, *Sebastes carnatus*
- Grass rockfish, *Sebastes rastrelliger*
- Greenblotched rockfish, *Sebastes rosenblatti*
- Greenspotted rockfish, *Sebastes chlorostictus*
- Greenstriped rockfish, *Sebastes elongatus*
- Harlequin rockfish, *Sebastes variegatus*
- Honeycomb rockfish, *Sebastes umbrosus*
- Kelp rockfish, *Sebastes atrovirens*
- Mexican rockfish, *Sebastes macdonaldi*
- Olive rockfish, *Sebastes serranoides*
- Pacific ocean perch, *Sebastes alutus*
- Pink rockfish, *Sebastes eos*
- Quillback rockfish, *Sebastes maliger*
- Redbanded rockfish, *Sebastes babcocki*
- Redstripe rockfish, *Sebastes proriger*
- Rosethorn rockfish, *Sebastes helvomaculatus*
- Rosy rockfish, *Sebastes rosaceus*
- Rougheye rockfish, *Sebastes aleutianus*
- Sharpchin rockfish, *Sebastes zacentrus*
- Shortbelly rockfish, *Sebastes jordani*
- Silvergray rockfish, *Sebastes brevispinis*
- Speckled rockfish, *Sebastes ovalis*
- Splitnose rockfish, *Sebastes diploproa*
- Squarespot rockfish, *Sebastes hopkinsi*
- Stripetail rockfish, *Sebastes saxicola*
- Tiger rockfish, *Sebastes nigrocinctus*
- Treefish, *Sebastes serriceps*
- Vermilion rockfish, *Sebastes miniatus*
- Widow rockfish, *Sebastes entomelas*
- Yelloweye rockfish, *Sebastes ruberrimus*
- Yellowmouth rockfish, *Sebastes reedi*
- Yellowtail rockfish, *Sebastes flavidus*

Other Flatfishes
- Arrowtooth flounder, *Atheresthes stomias*
- Butter sole, *Pleuronectes isolepis*
- English sole, *Pleuronectes vetulus*
- Flathead sole, *Hippoglossoides elassodon*
- Pacific sanddab, *Citharichthys sordidus*
- Petrale sole, *Eopsetta jordani*
- Rex sole, *Errex zachirus*
- Rock sole, *Pleuronectes bilineatus*
- Sand sole, *Psettichthys melanostictus*
- Starry flounder, *Platichthys stellatus*

Others
- Leopard shark, *Triakis semifasciata*
- Soupfin shark, *Galeorhinus zyopterus*
- Spiny dogfish, *Squalus acanthias*
- Big skate, *Raja binoculata*
- California skate, *Raja inornata*
- Longnose skate, *Raja rhina*
- Spotted ratfish, *Hydrolagus colliei*
- Finescale codling, *Antimora microlepis*
- Pacific rattail, *Coryphaenoides acrolepis*
- Cabezon, *Scorpaenichthys marmoratus*
- Kelp greenling, *Hexagrammos decagrammus*
- Lingcod, *Ophiodon elongatus*
- Pacific cod, *Gadus macrocephalus*
- California scorpionfish, *Scorpaena guttata*

UNIT 16: WESTERN PACIFIC INVERTEBRATE FISHERIES

- Spiny lobster, *Panulirus marginatus*
- Slipper lobster, *Scyllarides squamosus*
- Precious corals, Order Zoanthidea, Family Gorgoniidae

UNIT 17: WESTERN PACIFIC BOTTOMFISH AND ARMORHEAD FISHERIES	Reef Fishes Silverjaw jobfish, *Aphareus rutilans* Gray jobfish, *Aprion virescens* Squirrelfish snapper (ehu), *Etelis carbunculus* Longtail snapper (onaga), *Etelis coruscans* Bluestripe snapper, *Lutjanus kasmira* Yellowtail snapper, *Pristipomoides auricilla* Pink snapper (opakapaka), *Pristipomoides filamentosus* Yelloweye snapper, *Pristipomoides flavipinnus* Snapper, *Pristipomoides sieboldii, Pristipomoides zonatus* Giant trevally (ulua), *Caranx ignobilis* Black jack, *Caranx lugubris*	Thick lipped trevally, *Pseudocaranx dentex* Greater amberjack, *Seriola dumerili* Blacktip grouper, *Epinephelus fasciatus* Seabass, *Epinephelus quernus* Lunartail grouper, *Variola louti* Ambon emperor, *Lethrinus amboinensis* Redgill emperor, *Lethrinus rubrioperculatus* Seamount Fishes Pelagic armorhead, *Pseudopentaceros wheeleri* Alfonsino, *Beryx splendens* Raftfish, *Hyperoglyphe japonica*
UNIT 18: PACIFIC HIGHLY MIGRATORY PELAGIC FISHERIES	Swordfish, *Xiphias gladius* Blue marlin, *Makaira nigricans* Striped marlin, *Tetrapturus audax* Albacore (North & South), *Thunnus alalunga* Bigeye tuna, *Thunnus obesus* Yellowfin tuna, *Thunnus albacares* Skipjack tuna, *Katsuwonus pelamis* Other Pelagics Sailfish, *Istiophorus platypterus* Black marlin, *Makaira indica*	Shortbill spearfish, *Tetrapturus angustirostris* Dolphin (mahimahi), *Coryphaena hippurus* Oceanic sharks, Families—Carcharhinidae, Alopiidae, Sphyrnidae, and Lamnidae Wahoo, *Acanthocybium solandri* Hawaiian monk seal, *Monachus schauinslandi*
UNIT 19: ALASKA GROUNDFISH FISHERIES	Walleye (Alaska) pollock, *Theragra chalcogramma* Pacific cod, *Gadus macrocephalus* Sablefish (black cod), *Anoplopoma fimbria* Yellowfin sole, *Pleuronectes asper* Pacific halibut, *Hippoglossus stenolepis* Other Flatfishes Arrowtooth flounder, *Atheresthes stomias* Greenland halibut, *Reinhardtius hippoglossoides* Rock sole, *Pleuronectes bilineatus* Flathead sole, *Hippoglossoides elassodon* Alaska plaice, *Pleuronectes quadrituberculatus* Rex sole, *Errex zachirus* Butter sole, *Pleuronectes isolepis* Longhead dab, *Pleuronectes proboscideus* Dover sole, *Microstomus pacificus* Starry flounder, *Platichthys stellatus* Rockfishes Pacific ocean perch, *Sebastes alutus* Thornyhead rockfish, *Sebastolobus* spp.	Rougheye rockfish, *Sebastes aleutianus* Dusky rockfish, *Sebastes ciliatus* Northern rockfish, *Sebastes polyspinis* Shortspine thornyhead, *Sebastes alascanus* Shortraker rockfish, *Sebastes borealis* Darkblotched rockfish, *Sebastes crameri* Sharpchin rockfish, *Sebastes zacentrus* Yelloweye rockfish, *Sebastes ruberrimus* Blue rockfish, *Sebastes mystinus* Others Atka mackerel, *Pleurogrammus monopterygius* Rattail, *Coryphaenoides* spp. Skates, *Raja* spp. Squids, Sepioidea and Teuthoidea Octopus, Octopoda Northern (steller) sea lion, *Eumetopius jubatus* Tanner (snow) crabs, *Chionoecetes* spp. King crabs, *Paralithodes* spp., *Lithodes* spp.

UNIT 20: ALASKA SHELLFISH FISHERIES

King crabs
- Red king crab, *Paralithodes camtschatica*
- Blue king crab, *Paralithodes platypus*
- Golden (brown) king crab, *Lithodes aequispina*

Tanner (snow) crabs, *Chionoecetes bairdi*, *C. opilio*

Sea Snails, *Neptunea pribiloffensis*, *N. heros*, *N. lyrata*, *N. ventricosa*, *Fusitriton oregonensis*, *Buccinum angulossum*, *B. plectrum*, *B. scalariforme*, *B. polare*, *Volutopsius middindorffii*, *V. fragilis*, *Plicifusus kroyeri*, *Pyrulofusus deformis*

UNIT 21: NEARSHORE FISHERIES

Tarpon, *Megalops atlanticus*
Ladyfish, *Elops saurus*
Bonefish, *Albula vulpes*
American eel, *Anguilla rostrata*
Other shads, herrings, *Alosa aestivalis*, *Alosa alabamae*, *Alosa mediocris*, *Dorosoma cepedianum*, *Dorosoma petenense*, *Etrumeus teres*, *Harengula clupeola*, *Harengula humeralis*, *Harengula jaguana*
Atlantic thread herring, *Opisthonema oglinum*
Spanish sardine, *Sardinella aurita*
Surf smelt, *Hypomesus pretiosus*
Eulachon, *Thaleichthys pacificus*
Ballyhoo, *Hemiramphus brasiliensis*
Common snook, *Centropomus undecimalis*
Striped bass (Pacific), *Morone saxatilis*
Florida pompano, *Trachinotus carolinus*
Permit, *Trachinotus falcatus*
California corbina, *Menticirrhus undulatus*
Surfperches, Family Embiotocidae
Mullets, Family Mugilidae
Tautog, *Tautoga onitis*
Abalone, *Haliotis* spp.
Pacific shrimps, Family Pandalidae
Dungeness crab, *Cancer magister*
Atlantic rock crab, *Cancer irroratus*
Jonah crab, *Cancer borealis*
Blue crab, *Callinectes sapidus*
Blue mussel, *Mytilus edulis*
Pacific razor clam, *Siliqua patula*
Pismo clam, *Tivela stultorum*
Pacific hard clams, Family Veneridae
Northern quahog, *Mercenaria mercenaria*
Softshell, *Mya arenaria*
Bay scallop, *Argopecten irradians*
Atlantic calico scallop, *Argopecten gibbus*
Eastern oyster (Atlantic), *Crassostrea virginica*
Pacific oyster, *Crassostrea gigas*
Sea urchins, *Strongylocentrotus* spp.

UNIT 22: ATLANTIC MARINE MAMMALS

Right whale, *Eubalaena glacialis*
Humpback whale, *Megaptera novaeangliae*
Longfin pilot whale, *Globicephala melas*
Shortfin pilot whale, *Globicephala macrorhynchus*
Harbor porpoise, *Phocoena phocoena*
Bottlenose dolphin, *Tursiops truncatus*
Harbor seal, *Phoca vitulina*
Grey seal, *Halichoerus grypus*

Other Marine Mammals
- Fin whale, *Balaenoptera physalus*
- Whitesided dolphin, *Lagenorhynchus acutus*
- Striped dolphin, *Stenella coeruleoalba*
- Spotted dolphin (Atlantic), *Stenella plagiodon*
- Beaked whales, *Mesoplodon* spp.
- Bottlenose whales, *Hyperoodon* spp.

UNIT 23: PACIFIC MARINE MAMMALS

Eastern Tropical Pacific Porpoises
- Spinner dolphin, *Stenella longirostris*
- Spotted dolphin (Pacific), *Stenella attenuata*
- Striped dolphin, *Stenella coeruleoalba*
- Common dolphin, *Delphinus delphis*

Bowhead whale, *Balaena mysticetus*
Gray whale, *Eschrichtius robustus*
Humpback whale, *Megaptera novaeangliae*
Northern (steller) sea lion, *Eumetopias jubatus*
Northern fur seal, *Callorhinus ursinus*
Hawaiian monk seal, *Monachus schauinslandi*
California sea lion, *Zalophus californianus*

Other Marine Mammals
- Dall's porpoise, *Phocoenoides dalli*
- Harbor porpoise, *Phocoena phocoena*

. . . PACIFIC MARINE MAMMALS	Other Marine Mammals (cont.) Northern right-whale dolphin, *Lissodelphis borealis* Whitesided dolphin, *Lagenorhynchus obliquidens*	Harbor seal, *Phoca vitulina* Ribbon seal, *Histriophoca fasciata* Blue whale, *Balaenoptera musculus* Guadalupe fur seal, *Arctocephalus townsendi*
UNIT 24: SEA TURTLES	Kemp's ridley sea turtle, *Lepidochelys kempi* Olive ridley sea turtle, *Lepidochelys olivacea* Leatherback sea turtle, *Dermochelys coriacea*	Green sea turtle, *Chelonia mydas* Loggerhead sea turtle, *Caretta caretta* Hawksbill sea turtle, *Eretmochelys imbricata*

Appendix Table 1.– Percentage of LTPY from each unit attributed to each region. This apportionment is used to calculate region yield and value for Figure 2. The percentages are calculated based on landings data from 1989 to 1991.

Unit	Northeast	Southeast	Coastal Pacific	Oceanic Pacific	Alaska
1	100%				
2	100				
3	100				
4	100				
5	50	50%			
6		100			
7		100			
8		100			
9		100			
10	33	67			
11		100			
12			100%		
13					100%
14			100		
15			100		
16				100%	
17				100	
18				100	
19					100
20					100
21	25	50	25		

ACRONYMS AND ABBREVIATIONS

AB	Aleutian Basin
ABC	Acceptable biological catch
ADFG	Alaska Department of Fish and Game
AI	Aleutian Islands
AFSC	Alaska Fisheries Science Center
ASBCA	Atlantic Striped Bass Conservation Act
ASMFC	Atlantic States Marine Fisheries Commission
ATCA	Atlantic Tunas Convention Act
B	Biomass
BSAI	Bering Sea/Aleutian Islands Region
C	Celsius, centigrade
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CFMC	Caribbean Fishery Management Council
CI	Confidence intervals
CL	Confidence limits
CLF	Conservation Law Foundation
cm	Centimeter
CNMI	Commonwealth of the Northern Mariana Islands
CPUE	Catch per unit of effort
CPY	Current potential yield
CV	Coefficient of variation
CWP	Central-Western Pacific Ocean
D	Depleted under the Marine Mammal Proctection Act
E	Endangered under the Endangered Species Act
EBS	Eastern Bering Sea
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
ETP	Eastern Tropical Pacific Ocean
F_{max}	Rate of fishing mortality that results in the maximum level of yield per recruit.
FFA	Forum Fisheries Agency
fm	Fathom
F	Fishing mortality rate
FMC	Fishery Management Council
FMP	Fishery Management Plan
GIFA	Governing International Fisheries Agreement
GOA	Gulf of Alaska
GSMFC	Gulf States Marine Fisheries Commission
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICNAF	International Commission for the Northwest Atlantic Fisheries
IFQ	Individual fishing quota
INPFC	International North Pacific Fisheries Commission
IPHC	International Pacific Halibut Commission
ISFMP	Interstate Fisheries Management Plan for Striped Bass
ITQ	Individual transferable quota
IWC	International Whaling Commission
K	Environmental carrying capacity
kg	Kilogram

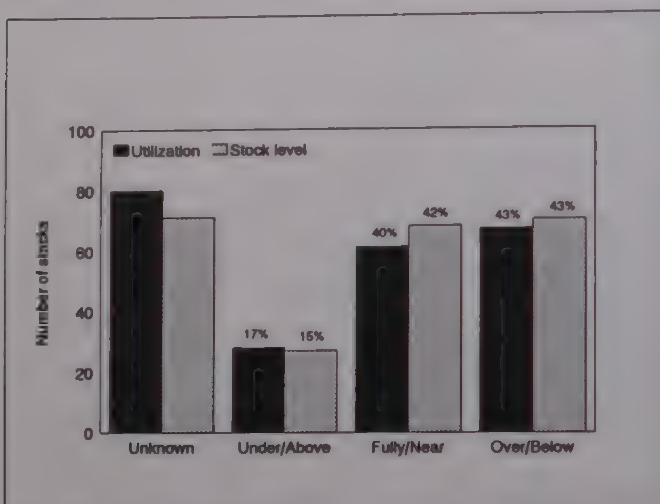
LMR	Living marine resource(s)
LPUE	Landings per unit of effort
LTPY	Long-term potential yield
m	Meter
M	Million
MFCMA	Magnuson Fisheries Conservation and Management Act of 1976
MHI	Main Hawaiian Islands
mm	Millimeter
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service, Department of Interior
MRFSS	Marine Recreational Fishery Statistical Survey
MSY	Maximum sustainable yield
NASCO	North Atlantic Salmon Conservation Organization
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPAFC	North Pacific Anadromous Fish Commission
NPFMC	North Pacific Fisheries Management Council
NPTZ	North Pacific Transition Zone
NWFSC	Northwest Fisheries Science Center
NWHI	Northwestern Hawaiian Islands
OY	Optimum yield
OSP	Optimum sustainable population
P	Proposed for listing under Endangered Species Act
PFMC	Pacific Fisheries Management Council
PFMP	Preliminary Fishery Management Plan
POP	Pacific ocean perch
PSC	U.S.-Canada Pacific Salmon Commission
PSP	Paralytic shellfish poisoning
RAY	Recent annual yield
RVOD	Research vessel observer data
SBS	Striped bass study
SE	Standard error
SEFSC	Southeast Fisheries Science Center
SNE	Southern New England
SPR	Spawner per recruit
SSB	Spawning stock biomass
STCZ	Subtropical Convergence Zone
SWFSC	Southwest Fisheries Science Center
T	Threatened under the Endangered Species Act
t, mt	Metric ton
TAC	Total allowable catch
TED	Turtle excluder device
TL	Total length
TVOD	Tuna vessel observer data
UNGA	United Nations General Assembly
USFWS	U.S. Fish and Wildlife Service
vtw	Vessel-ton-weeks
WPFMC	Western Pacific Fishery Management Council
YONAH	Years of the North Atlantic Humpback Whale (1992-95)

APPENDIX 7 ERRATA: OUR LIVING OCEANS, 1992

P. 4 (column 1, line 6)
"Fishery Management **Council's**" should read "Fishery Management **Councils**."

P. 9 (Table 1)
Unit 12, CPY = 142,700 (not 231,100); RAY = 92,016 (not 120,400)
Unit 14, LTPY = 43,366 (not 51,493); CPY = 43,366 (not 51,493); RAY = 36,190 (not 43,360)

P. 12 (Figure 5)
should show the following percentages:



P. 17 (column 1, first paragraph under heading "Management Concerns")
"**30%** of all stocks and **45%** of the stocks where status is known" should read "**28%** of all stocks and **43%** of the stocks where status is known."

P. 20 (column 1, first sentence under heading "Scientific Information and Adequacy of Assessments")
"**33%**" should read "**34%**."

P. 39 (column 1, first paragraph under heading "Bycatch and Multispecies Interactions")
"**range** of resources" should read "**diversity** of resources."

P. 41 (Table 2-1, footnote 4)
"**47%**" should read "**42%**" of the RAY.

P. 42 (column 1, lines 2-5)
should read **"Present commercial landings are well below CPY's. For the complex of stocks, CPY's exceed RAY's by 284% (473,500 t)."**

P. 47 (column 1, 5 lines from bottom)
"fishing rates **resulting in** maximum cohort yields" should read "fishing rates **that provide for** maximum cohort yields."

P. 49 (column 2, last four lines)
should read **"regulations control the length of the harvesting season (December to May) and harvest gear."**

P. 57 (column 2, 9 lines from the bottom)
"**53%**" should read "**58%**."

P. 58 (column 1, line 1)
"**25%**" should read "**27%**."

P. 64 (column 1, line 9)
"A classic example **it** the popularity of 'blackened redfish'" should read "A classic example **is** the popularity of 'blackened redfish.'"

P. 64 (column 2, second paragraph, line 5)
"adult population increases in **size**" should read "adult population increases in **population abundance**."

P. 66 (column 2, line 6)
"briefly during the spring of **1988**" should read "briefly during the spring of **1989**."

P. 75 (Table 12-1)
Add Footnote 3: "Conversion from numbers of fish to an approximate yield in weight may be obtained by applying the following estimates for average individual fish weight: chinook (7.95 kg), coho (3.0 kg), pink (1.85 kg), sockeye (2.09 kg), and chum (5.3 kg)."

P. 80 (Table 14-1)
Current potential yield (CPY), "231,100 t" should read "142,700 t"; Recent average yield (RAY), "120,400 t" should read "92,016 t"

P. 85 (column 2, lines 5-8)
"Its ex-vessel value was **$95** million" should read "Its ex-vessel value was **$101** million."
"The important species harvested were Pacific whiting (**290,600** t valued at **$94.5** million)" should read "The important species harvested were Pacific whiting (**210,400** t valued at **$32.1** million)."

P. 90 (Figures 16-2 and 16-3)
Y-axis label "Landings (1,000 t)" should read "Landings (t)"

P. 118 (column 1, paragraph under heading "Harbor Porpoise")
should begin **"The northwestern Atlantic harbor porpoise is found from Newfoundland to Florida."**

P. 146 (column 1, lines 8-9)
"***Chionecetes*** *bairdi*, ***Chionecetes*** *opilio*" should read "***Chionoecetes*** *bairdi*, ***Chionoecetes*** *opilio*."

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★